EVALUATION OF NASAL MASK VS FACE MASK FOR VENTILATION DURING INDUCTION OF GENERAL ANAESTHESIA IN OBESE PATIENTS

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I hereby declare that the thesis entitled "**EVALUATION OF NASAL MASK VS FACE MASK FOR VENTILATION DURING INDUCTION OF GENERAL ANAESTHESIA IN OBESE PATIENTS**" submitted towards partial fulfillment of the requirements for the award of **MD in Anaesthesiology** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. NEERU LUTHRA**, Professor, Department of Anaesthesiology and **Dr. SHIKHA GUPTA**, Professor, Department of Anaesthesiology. No part of this thesis has formed the basis for the award of any degree previously.

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Dedicated

to

my

grandfather

ABBRIVATIONS

AjBW	Adjusted Body weight
ASA	American Society of Anaesthesiologists
Bi-PAP	Bi-level Positive Airway Pressure
BMI	Body Mass Index
CPAP	Continuous Positive Airway Pressure
DMV	Difficult Mask Ventilation
ECG	Electrocardiogram
$ETCO_2$	End Tidal Carbon dioxide
FRC	Functional Residual Capacity
IBW	Ideal body weight
IV	Intravenous
MPS	Mallampati Score
MV	Mechanical Ventilation
OSA	Obstructive Sleep Apnea
PACU	Post Anaesthesia Care Unit
PaO_2	Arterial Oxygen Tension
PEEP	PeakEnd Expiratory Pressure
PIP	Peak Inspiratory Pressure
PPV	Positive Pressure Ventilation
SpO_2	Oxygen Saturation
SPSS	Statistical Package For Social Sciences
$VbCO_2$	Volume of carbon dioxide
VCV	Volume Controlled Ventilation
Vte	Expired Tidal Volume

ABSTRACT

Introduction: Mask ventilation is an important technique used during the induction of general anaesthesia. In the supine position decreased upper airway tone and the effect of gravity on the soft palate and tongue lead to upper airway obstruction. Upper airway obstruction under anaesthesia shares similarities with obstructive sleep apnea (OSA). Nasal CPAP has been successfully used in OSA as it provides a pneumatic splint and prevents upper airway collapse. Standard facemask ventilation technique is routinely practised in all anaesthesia procedures whereas nasal mask ventilation is not practised customarily. With this background, the present study has been designed to evaluate the efficacy of nasal masks and face masks for ventilation during the induction of general anaesthesia in obese patients

Objective:

1. To evaluate the efficacy of nasal mask ventilation against face mask ventilation in obese patients by comparing the Expired tidal volume.
2. To evaluate the Peak inspiratory pressure, plateau pressure, end-tidal carbon dioxide, and oxygen saturation using the two techniques

Methods: A prospective randomized study was conducted on 90 adult obese (BMI>25kg/m^2) patients posted for surgery under general anaesthesia, and were divided into two groups. Group A (facemask) and Group B (nasal mask) were ventilated as per group allocation using standardized parameters of the ventilator. Respiratory parameters (expired tidal volume, peak inspiratory pressure plateau pressure, oxygen saturation and end-tidal carbon dioxide) were recorded from both Group A and B and compared in the study.

Results: The mean expired tidal volume in group A (436.90±49.60ml) was similar to that in group B (455.98±55.64 ml) (P value > 0.05). Also, the mean peak inspiratory pressure was lower in the nasal mask group (14.79±1.34 cmH_2O) as compared to the facemask group (19.94±3.05 cmH_2O) ($p < 0.05$). The mean plateau pressure recorded was lower in the nasal mask group (12.04±1.21 cmH_2O) than in the facemask group (16.66±5.56 cmH_2O) ($p<0.05$). The mean end-tidal carbon dioxide measured during the study was comparable in both groups (nasal mask=29.89±1.84 ml, facemask=30.16±2.27 ml, $p>0.05$). The mean oxygen saturation measure was also similar (nasal mask-99.64±1.04 % facemask- 99.61±0.97 % $p>0.05$) in both groups; none of the patients had significant oxyhemoglobin desaturation.

Conclusion: Hence, we conclude that nasal mask ventilation is an effective method for ventilating obese apnoeic paralyzed adult patients during induction of general anaesthesia. It can be effectively used as an alternative to facemask ventilation during general anaesthesia induction.

Keywords: Nasal mask, obese, tidal volume, ventilation, peak pressure.

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INTRODUCTION

Mask ventilation is a vital component of airway management during the induction of general anaesthesia. It is the primary technique of ventilation before tracheal intubation or insertion of any airway device. The ability to establish adequate mask ventilation has, therefore, become a major step in any difficult airway algorithm[1]. The use of a face mask is common for preoxygenation, inhalational induction of anaesthesia, and as a means to provide oxygen and anaesthetic agent to both a spontaneous breathing patient and an anaesthetized, apnoeic patient via positive pressure ventilation(PPV). Mask ventilation includes two vital components; first, creating a complete seal between the mask and face to ensure no gas leaks, and second, maintaining a patent upper airway. The anticipation of a difficult airway is important for effective airway management. A study conducted by Langron et al. reported the incidence of difficult mask ventilation to be 5 %, which is correlated significantly with difficult intubation[2]. Factors like the presence of facial hair, obesity (BMI>25 kg/m^2), lack of or missing teeth, age over 55 years, and a positive history of snoring are predictors for difficult mask ventilation[3,4].

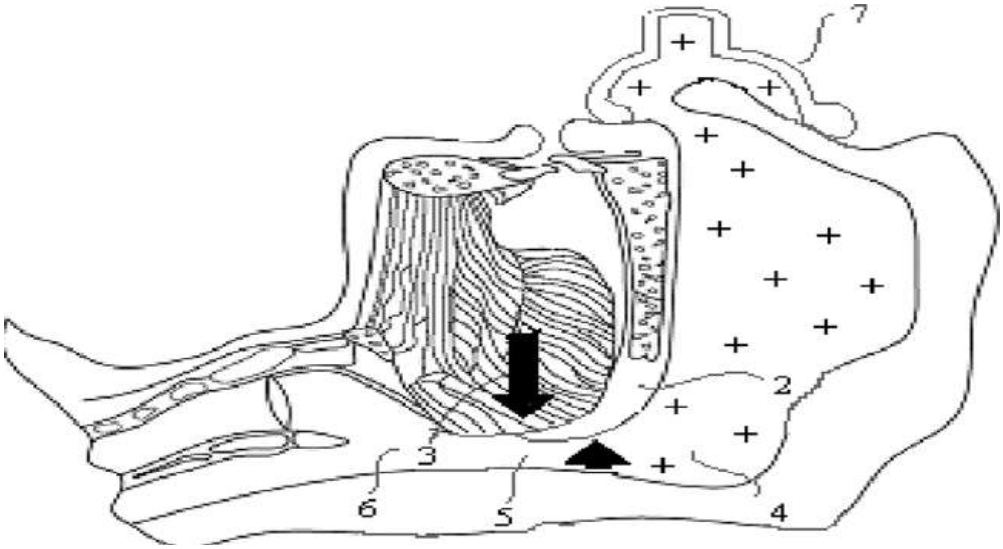
Obesity has been considered to be a risk factor for increased difficulty in airway management. The Fourth National Audit Project on major complications of airway management in the United Kingdom reported that obese patients had double the risk of airway problems and morbidly obese patients were four times more likely to develop airway problems during an anaesthetic procedure[5]. In obese patients, not only the external airway but also the anatomy of the oropharynx and larynx is altered[6]. Soft tissues such as the soft palate, lateral pharyngeal walls, tongue, and para-pharyngeal fat pads are larger than that in normal-weight individuals[7,8]. It is associated with decreased posterior airway space behind the base of the tongue, impaired airway patency during sleep, and is a risk factor for obstructive sleep apnea syndrome (OSA). Continuous positive airway pressure (CPAP) through a nasal mask has been used to successfully treat OSA as it provides a

pneumatic splint and prevents the collapse of the upper airway[9]. Fat deposits surrounding the pharyngeal airway may participate in a local mechanism of narrowing the upper airway creating anatomical imbalance within a normal bony enclosure size formed by the cervical vertebrae, maxilla, and mandible. Along with this, obese patients have increased airway resistance, an abnormally elevated diaphragm, and increased work of breathing secondary to abnormal chest wall elasticity and resistance to caudal excursion of the diaphragm[10]. In addition, the added weight of abdominal fat on inferior portions of the lung can reduce functional residual capacity (FRC) thus promoting a smaller and more collapse-prone upper airway[11]. These alterations result in shallow, rapid breathing, reductions in the capacity to pre-oxygenate, and limited ventilatory capacity.

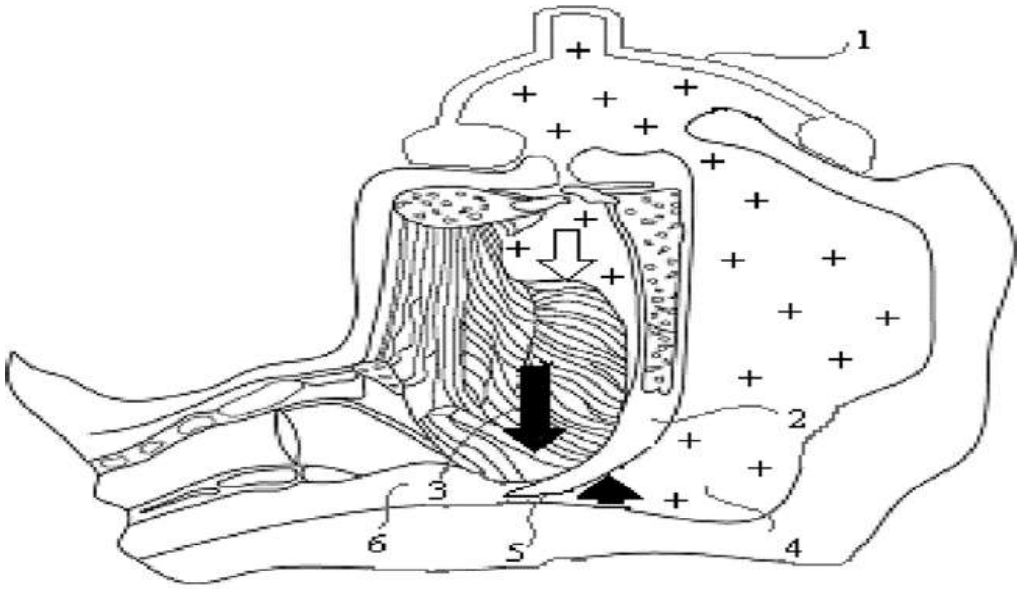
Facemask ventilation of a patient after induction of anaesthesia is often inefficient due to decreased upper airway tone which leads to airway obstruction. The backward displacement of the tongue and soft tissue in a patient placed supine adds to the difficulty[12]. To overcome the obstruction, higher airway pressures are required for adequate ventilation which may further lead to gastric insufflation resulting in vomiting and aspiration[11,13]. In cases in which inadequate facemask ventilation persists despite optimization strategies, alternative ventilation techniques can be helpful. Currently, there are multiple different styles of mask interfaces available. Most mask interfaces fall into 2 broad categories, either a nasal-only interface, which provides ventilation exclusively via the nasal route or an oro-nasal (facemask) interface which delivers ventilation to both the nasal and oral routes. Mechanism of upper airway obstruction under anaesthesia shares similarities with OSA[14]. The success of nasal mask PPV during anaesthesia is likely achieved by providing a pneumatic splint[9,15]. In a supine human, several forces determine whether the soft palate and tongue will fall backwards to obstruct the pharyngeal airway while ventilating the patient.

- First, gravity facilitates obstruction. It plays an important role in the mechanism of upper airway obstruction and sleep apnea because sleep-disordered breathing is reduced in the microgravity of outer space.
- Second, positive pressure in the oro-pharynx during facemask ventilation makes the tongue and soft palate fall posteriorly further worsening the obstruction.
- Third, obstruction is opposed by positive pressure in the nasopharynx, as during nasal mask ventilation, that generates force below the tongue and soft palate pushing them upward and opening up the airway.

The velopharynx is the most common site of collapse during anaesthesia in nonparalysed patients. As compared to facemask ventilation, no positive pressure is applied to the soft tissue of the tongue and mouth when using the nasal mask and the inspiratory tidal volume enters the airway through a relatively rigid course in the nasal cavity. The gradient between the nasopharynx and oropharynx can overcome the effect of gravity on the soft palate and tongue and thus maintain the patency of the upper airway[13].



Picture 1: Nasal mask ventilation: During nasal mask ventilation, positive pressure is generated only in the nasopharynx; the pressure gradient between the nasopharyngeal and oropharyngeal cavities can overcome the effect of gravity on the soft palate and the tongue, pushing forward and opening the upper airway[11].



Picture 2: Facemask ventilation: Full facemask applies positive pressure in both the nasopharyngeal and oral cavities and does not generate a pressure gradient between the two cavities. As a result, gravity forces the soft palate and tongue backwards, causing airway obstruction[11].

Studies have been done to compare facemasks versus nasal masks in adults. Liang et al. in a study on apnoeic, non-paralyzed, adult subjects during induction of general anaesthesia concluded that nasal mask ventilation was more effective than combined oral-nasal mask ventilation in removing the volume of carbon dioxide per breath. Along with ensuring more expiratory tidal volume, there is the advantage of a lower peak inspiratory pressure during nasal mask ventilation. Based on the result of the study they suggested that nasal mask ventilation, rather than full facemask ventilation, should be considered during the induction of anaesthesia[16]. In the case of edentulous patients studied by Kapoor, et al nasal mask ventilation was found to be more effective as the air leak was lower due to a better seal between the nasal mask and face. The placement of the inferior end of the nasal mask over the upper lip results in the contact of the mask with tissues with maxillary support, which is adequate in edentulous patients to provide an appropriate seal[11,17]. Ventilation through the nasal route leads to the

closure of the oropharynx by the tongue and thus reducing the oral leak.

In another study by Jiang et al. done on unconscious apnoeic adults, mouth-to-nasal breathing was shown to be more effective than mouth-to-mouth breathing when the head is in a neutral position. The expired tidal volume during mouth-to-nasal breathing was significantly greater than those achieved during mouth-to-mouth breathing. These results suggest that direct ventilation via the subject's nose may result in more effective ventilation[18].

Aghadavoudi et al. in a trial on obese patients compared ventilation using the standard mask ventilation with an anatomical nasal mask. The mean expiratory volume, mean SpO_2, mean end-tidal CO_2 ($EtCO_2$), and mean airway pressure were measured and compared in both groups, and that ventilation was found to be more efficient with a nasal mask than a face mask[3].

There are a few studies available that compared nasal mask ventilation with face mask ventilation during induction of anaesthesia in adult and edentulous patients and found nasal mask ventilation to be better in terms of delivered tidal volume and also lower airway pressures[11,16,18], However, very limited studies are available on the use of nasal mask ventilation during induction of anaesthesia in obese patients. Therefore, the present study was designed to compare the efficacy of nasal mask ventilation with facemask ventilation in obese patients undergoing surgery under general anaesthesia.

AIMS AND OBJECTIVES

To compare the effectiveness of nasal mask ventilation versus face mask ventilation in obese patients by evaluating:

1. Expired tidal volume(Vte),
2. Peak inspiratory pressure,
3. Plateau pressure,
4. End-tidal carbon dioxide and
5. Oxygen saturation.

REVIEW OF LITERATURE

MASK VENTILATION, COLLAPSIBILITY OF AIRWAY, AND OSA

Mask ventilation is a vital component of airway management during the induction of general anaesthesia. OSA shares commonalities with upper airway obstruction occurring during induction of general anaesthesia.

Upper airway obstruction during anaesthesia or sleep results from a combination of an anatomically predisposed airway and the permissive effect of muscle relaxation that is an inevitable consequence of these states[19]. Anatomic predisposition can be thought of in terms of the calibre and shape of the airway, extra luminal tissue pressure, and airway wall compliance. Obstruction is most likely to occur where substantial anatomic predisposition is present, posture is unfavourable (supine, mouth open, neck flexed), and muscle relaxation is profound (as in anaesthesia or rapid eye movement (REM) sleep). The tendency to collapse is countered by upper airway muscle activation. During natural sleep, when a sustained partial obstruction or complete obstruction occurs, the obstructed upper airway is re-opened by a brief arousal response, resulting in the return of muscle tone. During sedation, the decrease in muscle tone associated with reduction of consciousness is compounded by specific drug-induced inhibition of upper airway neural and muscular activity and suppression of protective arousal responses. Although the arousal response against sustained upper airway obstruction is a fundamental defensive mechanism in the compensatory neural system to maintain upper airway patency, this arousal response may be even more depressed as anaesthetic depth increases.

The pharynx is a collapsible segment of the upper airway. Pharyngeal wall compliance is a measure of its degree of flaccidity and, in the absence of muscle activity, reflects its intrinsic elastic properties and the degree of radial (transverse) and axial (longitudinal) tension to which it is subjected. A more compliant (flaccid) airway is more likely to collapse and, indeed, compliance is increased in OSA[20]. The

collapsibility of the upper airway was studied by Peter R east wood in the year 2010 who concluded that the collapsibility of the upper airway was directly associated with the depth of anaesthesia. Increasing the dose of propofol and subsequently, the depth of anaesthesia was associated with increased collapsibility of the upper airway. This was attributed to the profound inhibition of genioglossus muscle activity[21,22]. The dose-related inhibition appeared to be a combined effect of depression of central respiratory output to upper airway dilator muscle and upper airway reflex. The major findings were that at each level of anaesthesia, the mean pressure critical for the group exceeded or was close to atmospheric pressure, implying that the pharynx is vulnerable to collapse during anaesthesia, consistent with common clinical experience.

Obesity exerts its effects through increasing local compressive forces on the upper airway and by decreasing functional residual capacity (FRC), and therefore longitudinal traction on the upper airway, particularly when recumbent. There are familial predispositions to OSA. Patients of all weight ranges with a diagnosis of OSA are at increased risk of airway loss during procedures requiring anaesthetic sedation. In the majority of subjects, the upper airway collapsed at the level of the soft palate, and the site of collapse was unchanged by anaesthetic depth. Obese patients often have marked increases in pleural pressure; therefore, the recommended ceiling in airway pressure of 30 cm H_2O can be safely exceeded in such patients. Increased airway pressure can be concomitant with some complications including increased air insufflation into the stomach and increased risk of regurgitation and aspiration of gastric contents. A study published by Lee et al. done on 180 mechanically ventilated patients in an intensive care unit (ICU) reported obese patients (BMI>30kg/m^2) had significantly higher mean peak inspiratory pressures (34 cmH_2O in obese vs. 30 cm H_2O in non-obese, $p < 0.0002$) and mean plateau pressures (23 cmH_2O in obese vs. 20 cmH_2O in non-obese, p <

0.0001). They also observed that a significantly greater percentage of obese patients had plateau pressures >30 cmH_2O[23].

THE USE OF NASAL CPAP

Nasal CPAP is used to successfully treat OSA as it provides a pneumatic splint and prevents upper airway collapse[24]. The results of a study conducted on nasal CPAP by Yandong Jiang in 2013 suggested that the application of nasal CPAP maintains upper airway patency and produced more effective ventilation than facemask CPAP. CPAP during induction of anaesthesia probably reduces atelectasis formation, and thereby maintains oxygenation. Indeed, the reduced "safety window" (the time taken to develop desaturation following breathing oxygen before induction of anaesthesia) is much reduced in obese patients, and this may be prolonged by positive end-expiratory pressure(PEEP) or CPAP increasing lung volume and increasing the reservoir of O_2 available for diffusion into the capillary blood[14,18].

In another study in 2006 by Sylvian Gander to find out the effects of PEEP during induction of general anaesthesia and duration of nonhypoxic apnea in morbidly obese patients concluded from the study that application of positive pressure increased nonhypoxic apnea duration by 50%[15]. The possible reason was that nasal CPAP creates a positive pressure during both inspiration and expiration in the nasopharyngeal cavities which functions as a pneumatic splint that prevents upper airway obstruction by pushing the soft palate and the tongue forward and away from the posterior pharyngeal wall. Because the soft palate lies behind the tongue, the pressure gradient between the nasopharyngeal and oropharyngeal cavities pushes the soft palate and tongue forward, opening the airway. Nasal CPAP also increases lung volume and dilates the pharyngeal cavity[22].

A retrospective study was conducted in 1998 by C K Chan on patients who were admitted to the Respiratory Medical Unit of the Ruttonjee Hospital with acute hypercapnic respiratory failure and who received a bi-level continuous positive airway pressure (Bi-PAP) nasal mask. All 22 patients had received non-invasive ventilation because of persistent

hypoxemia (arterial oxygen tension [PaO_2] <60 mm Hg) and/or hypercapnia (arterial carbon dioxide tension [$PaCO_2$] >50 mm Hg) and/or an arterial pH <7.35, despite maximal medical treatment The Bi-PAP nasal mask ventilation was initiated in the high dependency unit for 12 (55%) of the patients, and in a respiratory medical ward for the remainder. The results showed that the nasal mask group had a significantly higher PaO_2, a higher oxygenation ratio, arterial-alveolar ratio, lower respiratory rate, and pulse rate showed that, in selected patients with acute hypercapnic respiratory failure, Bi-PAP nasal mask ventilation can be used successfully[25]. There was a significant improvement in arterial oxygen tension. The differences suggest that Bi-PAP nasal mask ventilation should be used early in the progression of respiratory failure.

An observational study by Ghebremichael et al in the year 2017 on 30 adult patients who had a BMI more than 30 mg/kg^2, undergoing general anaesthesia for elective surgery demonstrated that nasal mask ventilation facilitates non-invasive PPV, while allowing adequate oxygenation and ventilation for a variety of patients, including those who were edentulous, had a Mallampati score (MPS) of 3, and a BMI above 30 kg/m^2. Using a hyperinflation bag attached to the nasal mask allows for continued positive pressure support and/or rescue ventilation during patient transport and recovery in the post anaesthesia care unit (PACU). The study also concluded that the rate of effective tidal volume was significantly higher and the median expired tidal volume was significantly larger with nasal mask ventilation than with face masks[26]. The SuperNO_2V nasal mask's intended use and method of oxygen delivery were found to be very similar to other ventilation devices, such as nasal (CPAP) or high frequency nasal cannula (HFNC), by allowing continuous airflow and positive airway pressure to drive oxygen into the airway (from the nasopharynx), actively inflate the lungs to allow for CO_2 removal (creating a vacuum effect) and relieve upper airway obstruction with a positive airway pressure near 20 cm H_2O or higher (pneumatic stent).

A meta-analysis published by Andrade, Rafaela G S, et al. in 2017 concluded that the meta-analysis indicates that oro-nasal masks are associated with a higher CPAP level, higher residual, apnea-hypopnea index (AHI), and poorer adherence than nasal masks. Therefore, patients using oro-nasal masks should be closely monitored. Nasal interfaces should always be the first choice. There is evidence that the prolonged use of nasal CPAP reduces mouth opening and oral breathing. Therefore, even patients with OSA who claim to be mouth breathers could be initiated with nasal masks. Another clinical implication is that sleep studies for CPAP titration must be performed with the same type of mask that the patient will use at home[(27)].

NASAL MASK VENTILATION FOR ANAESTHESIA INDUCTION

The nasal mask was compared with the facemask by Yafen Liang in his study on normal adults by comparing the CO_2 removed per breath and expired tidal volume. A total of 17 subjects were enrolled belonging to ASA groups I and II. Two subjects were excluded because of the inability to achieve an adequate mask seal. As a result, 15 subjects completed the study protocol. Anesthesia was induced and thirty seconds after the subject's spontaneous breathing ceased, defined by measuring zero flow through both nasal and oral masks, they were ventilated with a volume-controlled operating room ventilator. ventilation parameters, including respiratory rate, tidal volume, flow waveforms, flow rates during inspiration and expiration, peak inspiratory airway pressure (PIP), end-tidal carbon dioxide partial pressure, and exhaled carbon dioxide waveforms, were recorded with the NICO monitors. The primary findings of this study are summarized as nasal mask ventilation: (1) Removed more carbon dioxide, (2) Required a lower PIP to effectively ventilate, and (3) Generated higher tidal volume than combined oral-nasal mask ventilation[(16)].They concluded that nasal mask ventilation was more effective than face mask ventilation in an apnoeic, non-paralyzed subject as the amount of CO_2 removed per breath was significantly larger in the case of nasal

ventilation as compared to facemask ventilation during induction of general anaesthesia[16].

A study was conducted by T. Itagaki et al. to compare the effectiveness of nasal mask ventilation vs facemask ventilation in an anaesthetized, apnoeic paediatric subject over 2 years of age. The investigators hypothesized that anaesthetized, apnoeic children could be ventilated equivalently or more efficiently by nasal mask ventilation (NMV) than face mask ventilation (FMV). 41 subjects of age group 3-17 years were enrolled into the study and randomly allocated into either nasal mask or face mask group. Both groups were ventilated with pressure control ventilation (PCV) at 20 cmH_2O of PIP with PEEP levels of 0, 5, and 10 cmH_2O. An additional mouth-closing manoeuvre (MCM) was applied for the NMV group. They found that expired tidal volume was higher in the FMV group compared with the NMV group when the MCM was not applied. NVM achieved less PEEP than FMV though both groups achieved the set PIP level. In the NMV group, MCM markedly increased Expired Tidal volume (Vte) and PEEP however, PEEP was highly variable and lower than that of FMV[28].

Mukul Chandra compared the efficacy of nasal mask ventilation against face mask ventilation in edentulous patients. The study was conducted on seventy-nine edentulous patients. Delivered and Vte were measured with two spirometry sensors (Integrated in AV-S Ventilator, Penlon Limited, Abingdon, UK), placed in the delivery and expired ends of the anaesthesia breathing system. While using the face mask, impossible mask ventilation was encountered in 3 patients, but only one was impossible to ventilate when a nasal mask was used. Reasonable ventilation was delivered in all cases and no patient had oxyhemoglobin desaturation. This study concluded that nasal mask ventilation is better than facemask ventilation as the air leak was lower due to better contact between the facial tissues and nasal mask in the scenario of edentulous patients[11].

The study by Yandong Jiang also concluded that ventilation delivered via the nose is significantly more effective than that delivered via the

mouth in anaesthetized apnoeic adults. A total of 24 subjects were enrolled in this study. Anesthesia was induced and upon cessation of spontaneous breathing, subjects were ventilated via Mouth to mouth breathing (MMB) or mouth-to-nasal breathing (MNB) delivered by an operator. The intraoral pressure of the operator was measured via a flexible tube in the operator's mouth that was connected to carbon dioxide/pressure/gas flow sensors. The profiles of the inspiratory airway pressure during MMB and MNB were recorded. The operator inhaled 100% oxygen via a partial rebreathing mask before delivering each breath. The most important findings of this study are (a) MNB is more effective than MMB when the head is in a neutral position, and (b) the Vte is smaller than the corresponding inspired tidal volume during MNB in the head extended position. The most likely cause of the less effective oral route ventilation, MMB, in the study was presumed to be upper airway obstruction these results suggested that direct ventilation via the subject's nose may result in more effective ventilation than that via the mouth during emergencies, such as cardiopulmonary resuscitation (CPR)[18].

A study conducted by aghadavoudi et al.on comparing nasal masks with facemasks also concluded that ventilation with a nasal mask is more efficient than a face mask in patients with a BMI>25 kg/m^2 and is followed by a reduced amount of risk and complications[3].Difficult mask ventilation may be related to the narrowing of space posterior to the tongue and the consequent airway obstruction. This phenomenon is similar to OSA by the posterior displacement of the tongue, uvula, and epiglottis, justifying the fewer non-ventilation cases in the nasal mask group compared to the face mask group.One of the quantitative measures related to the quality of ventilation in this study was SpO_2, which was significantly higher in the nasal mask group.Another result of the present study was the lower airway pressure in the nasal mask group.It indicated that increased pressure is a way to overcome the mechanical obstruction occurring in the airway, which correlates with the mechanisms of creating a higher pressure in the oral cavity by a

face mask to achieve a comparable amount of tidal volume as compared to a nasal mask.

In another study aghadavoudi et al. compared ventilation quality after general anaesthesia induction in children aged 3 to 12 years using a face anatomical mask or nasal mask. The sample was calculated as 35 patients in each group. The first group was ventilated with an anatomical face mask and 100% oxygen for three minutes. In the second group, ventilation was performed through a nasal mask and 100% oxygen for three minutes. In both groups, ventilation was performed with the help of the anaesthesia machine control mode. The mean expiratory flow volume, mean volumes of SpO_2 and $EtCO_2$ and mean volume of maximum airway pressure in three consecutive breaths in the second minute after ventilation initiation were measured in both groups. The mean Vte and maximal airway pressure in three consecutive breaths were not significantly different between the two groups at any time. The mean $EtCO_2$ in the second minute after the start of ventilation was significantly higher in the nasal mask group than in the face mask group, but there was no significant difference between the two groups in the fifth minute after endotracheal intubation. They concluded that since the nasal mask does not create positive pressure on the tongue and soft palate and the difficulty of the nasal airway, a collapse does not occur with this method. Hence, nasal masks can be used as an alternative in children due to the anatomical features of the airways and the possibility of further airway obstruction, and in other people in whom sealing is difficult, the possibility of preparing a face mask is low[29,30].

Another study was conducted by Hamid Hajigholam Saryazdi which aimed to compare ventilation quality by anatomic or nasal mask after general anaesthesia induction in patients with BMI above 40 kg/m^2. Evaluation of hemodynamic parameters during and after surgery did not show any clinical difference between the two groups. However, nasal ventilation patients had better ventilation and oxygenation. The results of the study showed that the use of a nasal mask instead of an

oral mask has a more favourable ventilation $ETCO_2$ and SpO_2 in patients undergoing surgery, and the same hemodynamic stability after induction of anaesthesia in very obese patients[31].

A study was conducted by CA Kushida et al. to evaluate the usability and efficacy of the Pixi paediatric nasal mask in children with Sleep-disordered breathing (SDB) receiving PAP (positive airway pressure) therapy. Forty-one consecutive eligible patients were invited to participate in the study. The primary endpoint was the equivalence of AHI values during PAP therapy using the Pixi mask compared with the patient's previous mask. Secondary endpoints were the extent of the unintentional leak, patient/legal guardian satisfaction with the mask, and treatment adherence. The Pixi mask was at least equivalent to previous interfaces in children receiving PAP therapy. It was easy to use and was well-accepted by patients and their caregivers. Given the shortage of child-specific options for the delivery of PAP therapy, the Pixi mask offers a useful alternative for the delivery of treatment for SDB in paediatric patients[32].

A study published by Lim et al. on a comparison of World Health Organization and Asia-Pacific BMI classifications in COPD patients demonstrated that the Asia-Pacific BMI classification more appropriately reflects the correlation of obesity and disease manifestation in Asian COPD patients than the WHO classification With the increasing prevalence of obesity in Asia, BMI as a disease predictor has increased in importance. However, there has been controversy when applying international criteria for obesity to an Asian population, and there have been attempts to reinterpret the BMI cut-offs for Asian and Pacific populations. Height and weight are the most simple and commonly used measures for the measurement of obesity. Several weight-for-height indices have been developed of which the BMI (defined as weight/height (kg/m^2)) is the most widely used. BMI generally correlates highly with adiposity, although it can sometimes misclassify total body fat content. For example, muscular athletes have a high BMI, due to muscle weighing more than fat, and will have BMIs

in the overweight range, even though they are not fat. It is not just the amount of fat but also its distribution that determines the risk associated with obesity. South Asians (Indians) have high levels of abdominal obesity, although they may not be considered obese by conventional BMI criteria. It is the mass of visceral adipose tissue which leads to these abnormalities The Asia-Pacific BMI cut-off In Asians for overweight (23.0 kg/m^2) and obesity (25.0 kg/m^2) is lower than the WHO criteria[33,34].

Biharz et al. presented their study, which details differences between actual body weight and calculated ideal body weight (IBW) in children receiving mechanical ventilation[35,36]. By using 3 different methods to calculate IBW, the investigators demonstrated that more than half of the subjects had clinically important differences between their actual and ideal weight, and all 3 methods for calculating IBW produced similar differences, of greatest concern was that the difference between ideal and actual body weight was more disparate in subjects who were heavier. In the subjects who were heavier, this difference between ideal and actual body weight was even more important given the potential implications on tidal volume. The patient's lung capacity is primarily determined by his or her age and height rather than by his or her current weight. Given the need to optimize lung-protective ventilation, we must provide the appropriate tidal volume. However, in obese patients, tidal volume targets could be overestimated when calculated according to actual body weight and requiring higher airway pressures to achieve the respective tidal volume thus exposing these patients to harmful volutrauma and barotrauma. This exposure works directly against the lung-protective strategies that have been proven to improve mortality in patients with acute respiratory distress syndrome (ARDS)[36]. Adjusted body weight can be used as a better predictor to accurately define tidal volume targets.

Adjusted body weight (AjBW) is calculated as:

AjBW = IBW + 0.4(ABW – IBW)

Estimated Ideal body weight(IBW) in (kg)[37] –

1. Males: IBW = 50 kg + 2.3 kg for each inch over five feet.
2. Females: IBW = 45.5 kg + 2.3 kg for each inch over five feet.

(ABW-actual body weight, AjBW-adjusted body weight, IBW-ideal body weight)

MATERIALS AND METHODS

SOURCE OF DATA

After approval of the Institutional ethics committee of Dayanand Medical College and Hospital, Ludhiana a randomized control study was performed on a total of 90 obese adult patients scheduled for surgery under general anaesthesia.

METHOD OF COLLECTION OF DATA

A prospective, randomised, interventional study was conducted on ASA I, II and III adults.90 patients were recruited in the study and an equal number were randomised using computer-generated random numbers contained in sealed, sequentially numbered envelopes, which were opened by an independent anaesthesiologist.

Inclusion criteria:

1. Age >18 years
2. BMI > 25 kg/m^{2}[19]

Exclusion criteria:

1. Patients having a contraindication to drugs used in the study
2. Patients with maxillofacial trauma
3. Pregnant patients
4. Edentulous patients
5. Presence of beard
6. Presence of Prognathia/retrognathia

GROUP ALLOCATION: A total 90 number of patients were recruited for the study and wererandomly allocated using a computer-generated random number list to either of the two groups, using consecutively numbered opaque sealed envelopes.

1. Group A-Patients were ventilated using a facemask.
2. Group B-Patients were ventilated using a nasal mask.

PREANAESTHETIC CHECKUP

A thorough pre-anaesthetic check-up comprising of detailed history, comorbidities, and allergy to any drug being used was conducted. Patients were explained about the study being conducted and written

informed consent was taken. Relevant investigations were sent and reviewed. Demographic information including height, weight, BMI, age, sex, neck circumference, and STOP-BANG score was recorded.

ANAESTHESIA TECHNIQUE

All patients were monitored using electrocardiography, heart rate, non-invasive blood pressure measurement, andSpO2 before induction of general anaesthesia. Appropriate mask size for the best fit was determined by keeping the mask at the nasal bridge on the upper end and below the lower lip at the lower end for the facemask. For the nasal mask, the upper end was kept at the nasal bridge and the lower end of the mask was kept above the upper border of the upper lip. The patient's head was placed in a neutral position on a pillow and elevated 10 cm from the operating room table. Trained anaesthesia practitioners with experience of more than 5 years performed mask ventilation. Facemask ventilation was performed by the thumb and index finger holding the mask down over the nose and mouth of the patient, forming a C while the other three fingers of the hand grasp the patient's mandible, forming an E and moving the mandible towards the upper teeth. The nasal mask ventilation was performed by holding the mask with the left hand by placing the thumb and index finger on the body of the mask, while the middle, ring, and little fingers move the mandible toward the maxilla to ensure closure of the mouth.

After preoxygenation with 100% oxygen for three minutes, patients were ventilated using the technique based on group allocation done using computer-generated random numbers. In group A, ventilation was performed using the standard facemask and in group B, patients were ventilated using the nasal mask. Anaesthesia was induced using an intravenous injection of fentanyl 2µg/kg followed by an injection of propofol 2 mg/kg. After the loss of consciousness and verification of the ability to ventilate, injection Atracuriumbesylate (0.5 mg/kg) was administered. Patients were ventilated with the volume-controlled mode(VCV) of ventilation at a pre-set fresh gas flow of 10 l/min, tidal volume of (6-7ml/kg), respiratory rate of 10 breaths/ min, pressure limit

of 40 cm H_2O for 2 minutes. The delivered tidal volume was set according to adjusted body weight (AjBW). Parameters (tidal volume, peak inspiratory pressure, plateau pressure, oxygen saturation and end-tidal carbon dioxide) were noted for ten breaths after verification of positive capnography tracing and expired tidal volume (Vte) in each case.

A mean value of the parameters of these ten breaths was calculated. If the patient was not ventilated adequately, defined as inadequate capnography trace/inadequate visual rising of the chest wall up to three breaths using a facemask or nasal mask or both, other airway adjuncts were used as a rescue airway.

Upon completion of the study, the subject's airway was secured in a normal manner by the placement of an endotracheal tube/laryngeal mask airway.

Observations:

PRIMARY OUTCOME:

To compare the effectiveness of nasal mask ventilation versus face mask ventilation in obese patients by evaluating the expired tidal volume.

SECONDARY OBJECTIVES: To compare the Peak inspiratory pressure, Plateau pressure, End-tidal carbon dioxide and Oxygen saturation using two techniques of ventilation.

Statistical Analysis:

The statistical analysis was carried out using IBM SPSS (Statistical Package for Social Sciences) statistical version 20. The analysis included frequency table, bar, pie chart, association of variables based on Chi-square test and if any cell frequency was <5, then yates corrections were used for 2x2 contingency table or method pooling and Fisher exact test was used (for higher order than 2x2 table) and proportion was compared using the z-proportion test. All quantitative variables were estimated using measures of central location (mean and median) and measures of dispersion (standard deviation). Normality of data was checked by Kolmogorov–Smirnov tests of normality. For

normality distributed data, Mean was compared with respect to independent t-test (for two groups). For not normality distributed data, Median was compared using Mann Whitney U test (for two groups). All statistical tests were seen at two-tailed level of significance ($p \leq 0.01$ and $p \leq 0.05$).

Power and Sample Size:

This calculator used the following formula for the sample size n:

$n = (Z_{\alpha/2}+Z_{\beta})^2 *2*\sigma^2 / d^2$,

where $Z_{\alpha/2}$ is the critical value of the Normal distribution at α/2 (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96), Z_{β} is the critical value of the Normal distribution at β (e.g. for a power of 90%, β is 0.1 and the critical value is 1.28), σ^2 is the population variance, and d is the difference.

F tests-t tests [Means: Difference between two dependent means (matched pairs)].
Analysis: Post hoc: Compute achieved power
Calculating power for mean 1 = mean 2 + difference
Alpha = 0.05
Assumed standard deviation (Interquartile range = 285.6)
Difference -199.2
Sample Size for each group-45
Power -0.90
Actual Power 0.905266
Total Sample Size =90

OBSERVATIONS AND RESULTS

This study was conducted in a randomized manner in the Department of Anaesthesiology, Dayanand Medical College and Hospital on a total of 90 adult patients of either sex, more than 18 years of age, with BMI more than 25 belonging to ASA grade I, II & III scheduled for surgeries under general anaesthesia.

The study aimed to compare the effectiveness of ventilation between facemasks and nasal masks in obese patients posted for surgeries under General Anaesthesia.Group A Patients were ventilated using a facemask and group B patients were ventilated using a nasal mask.

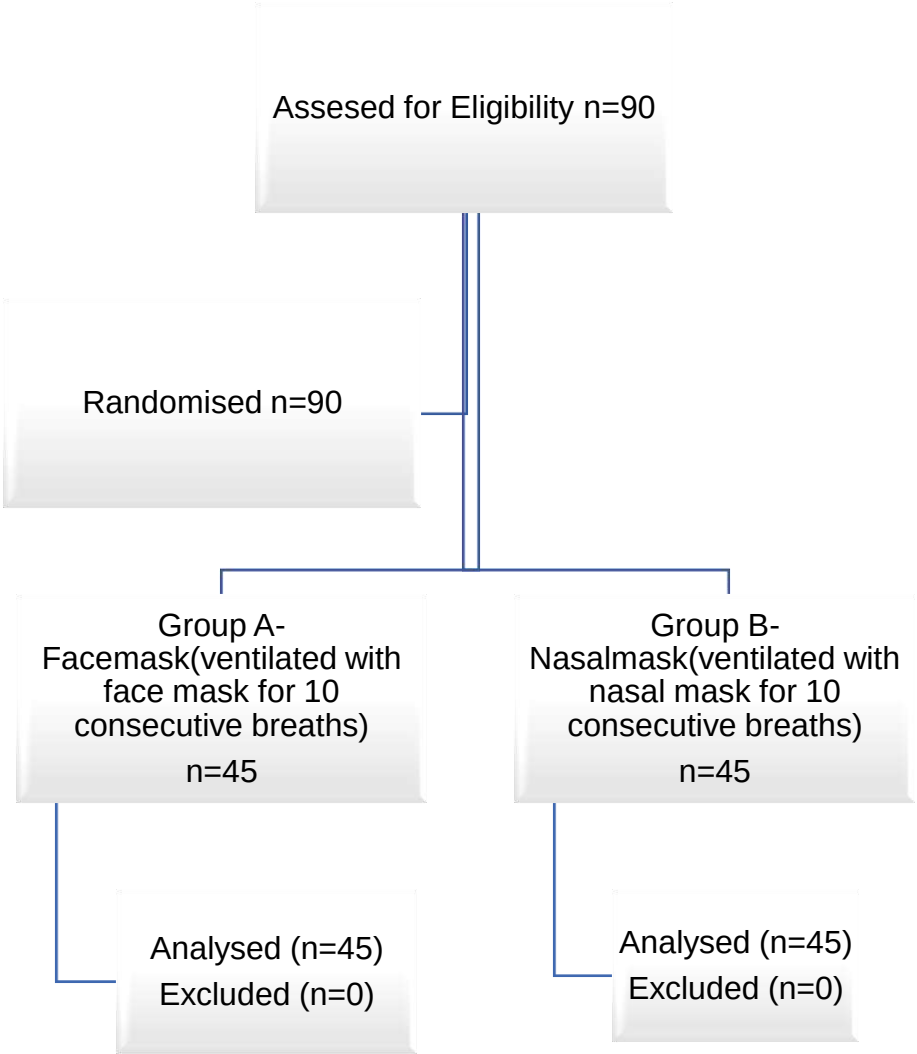

Assesed for Eligibility n=90
Randomised n=90
Group A- Facemask(ventilated with face mask for 10 consecutive breaths) n=45
Group B- Nasalmask(ventilated with nasal mask for 10 consecutive breaths) n=45
Analysed (n=45) Excluded (n=0)
Analysed (n=45) Excluded (n=0)

Figure 1: CONSORT Flow diagram of the study.

The Anaesthesia technique was standardised in both groups.

The observations of our comparative study are as follows:

➢ DEMOGRAPHIC PROFILE

Table 1: Mean age distribution of the patients.

		Facemask		Nasal mask		Total	Chi-square value	p-value
		Facemask	Facemask	Nasal mask	Nasal mask			
AGE GROUP(years)	< 30	7	15.6%	10	22.2%	17	4.276	0.37
	31-40	13	28.9%	7	15.6%	20		
	41-50	16	35.6%	13	28.9%	29		
	51-60	8	17.8%	14	31.1%	22		
	> 60	1	2.2%	1	2.2%	2		
Total		45	100.0%	45	100.0%	90		

The patients in the facemask Group were distributed as 7(15.6%) patients less than 30yrs of age, 13(28.9%) patients between 31-40 years 16(35.6%) patients between 41-50 years, 8(17.8%) patients between 51-60 years and 1(2.2%) patient above 60 years of age. In the Nasal mask group, patients were distributed as 10(22.2%) patients less than 30yrs of age, 7(15.6%) patients between 31-40 years 13(28.9%) patients between 41-50 years, 14(31.1%) patients between 51-60 years and 1(2.2%) patient above 60 years of age. There was no statistically significant difference between the two groups concerning age (p 0.37).

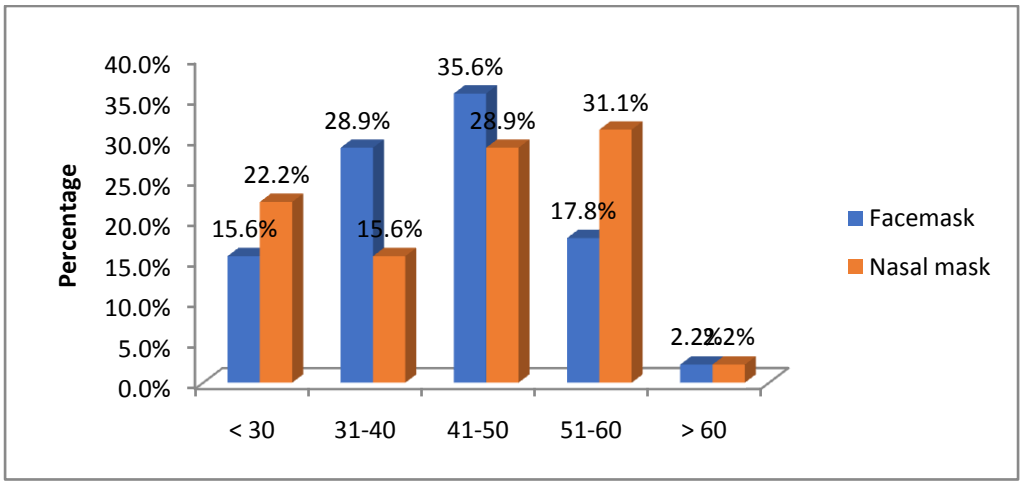


Figure 2: Mean age distribution of the patients.

Table 2: Sex Distribution of the patients.

		Facemask		Nasal mask		Total	Chi-square value	p-value
		No. of cases	%age	No. of cases	%age			
Sex	F	27	60.0%	26	57.8%	53	1.104	0.576
	M	18	40.0%	19	42.2%	37		
Total		45	100.0%	45	100.0%	90		

60.0% of the patients in the facemask group were females and 40.0% were males whereas, in the nasal mask group,57.8% were females and 42.2% were males. Both groups were comparable concerning sex distribution, with a p-value of 0.576.

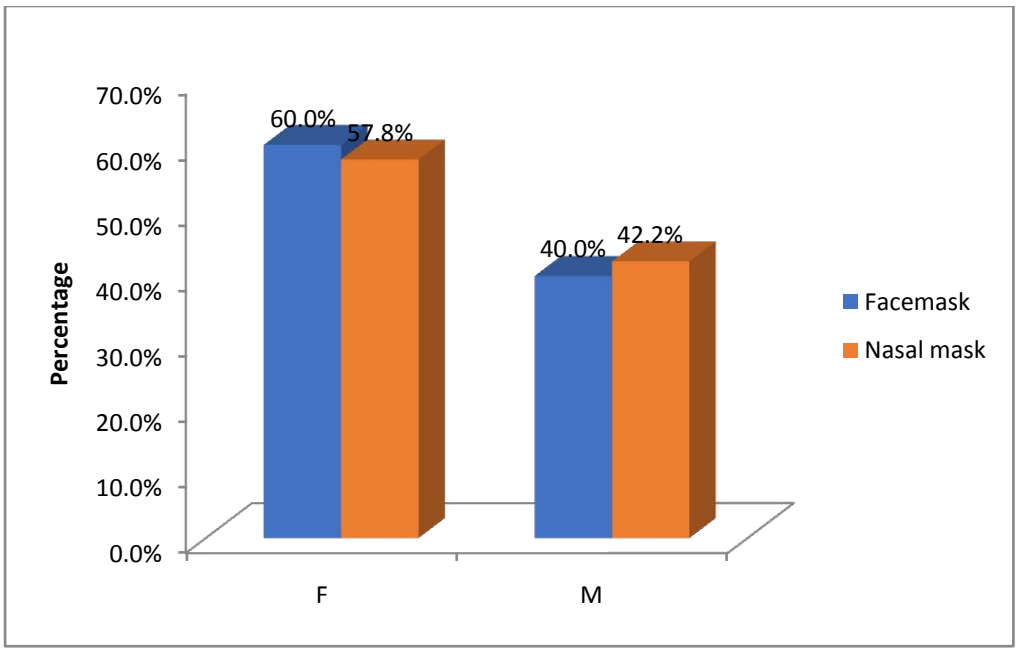


Figure 3: Sex Distribution of the patients.

Table 3: ASA Physical status of the patients.

Group		Facemask		Nasal mask		Total	Chi-square value	p-value
		No. of cases	%age	No. of cases	%age			
ASA Grade	I	16	35.60%	10	22.20%	26	3.676	0.159
	II	26	57.80%	27	60.00%	53		
	III	3	6.70%	8	17.80%	11		

The Facemask group comprised 35.6%(16) ASA I, 57.8%(26) ASA II, and 6.7%(3) ASA III patients respectively, whereas the nasal mask group comprised 22.2%(10) ASA I, 60%(27) ASA II and 17.8%(8) to ASA III patients respectively. Both the groups were statistically comparable with a p-value of 0.159.

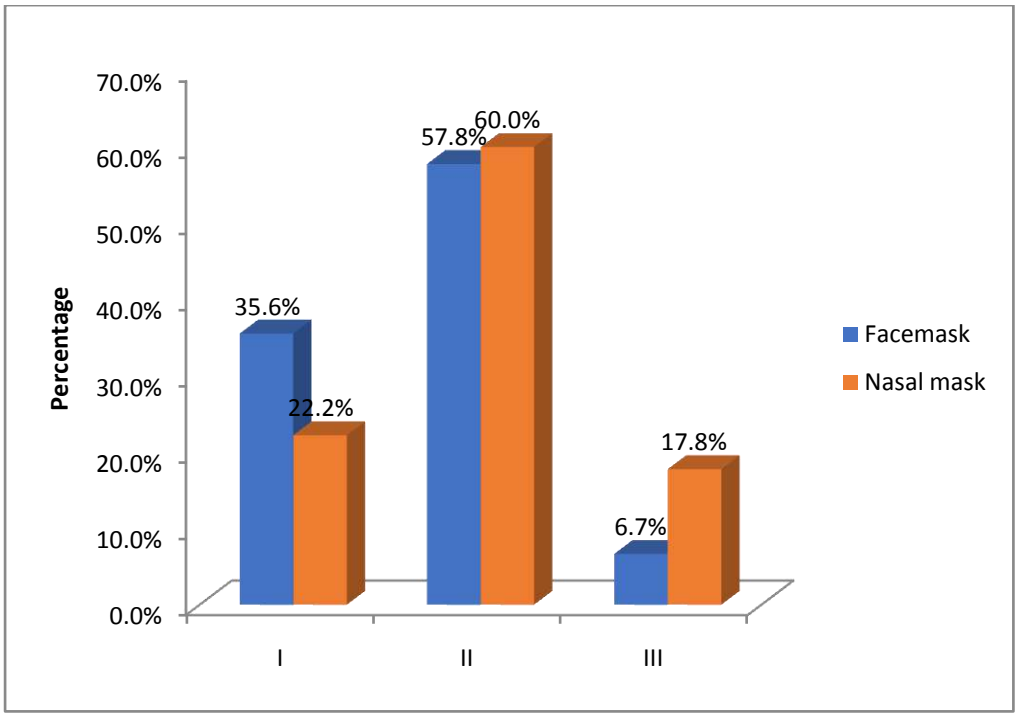


Figure 4: ASA physical status of the patients.

Table 4: Weight distribution of the patients.

	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
Actual body weight(kg)	80.84	9.12	82.22	8.87	-1.185	0.236
Adjusted body weight(kg)	66.93	7.46	67.49	7.57	-0.545	0.586
Ideal body weight(kg)	57.64	7.36	57.58	7.65	-0.057	0.955

The mean actual body weight of patients in the facemask group was 80.84±9.12 kg whereas, in the nasal mask group, it was 82.22±8.87 kg. The difference in mean actual body weight was statistically insignificant with a p-value of 0.236

The mean adjusted body weight of patients in the facemask group was 66.93±7.46 kg whereas, in the nasal mask group, it was 67.49±7.57 kg. The difference in mean adjusted body weight was statistically insignificant with a p-value of 0.586

The mean ideal body weight of patients in the facemask group was 57.64±7.36 kg whereas, in the nasal mask group, it was 57.58±7.65 kg. The difference in mean ideal body weight was statistically insignificant with a p-value of 0.955

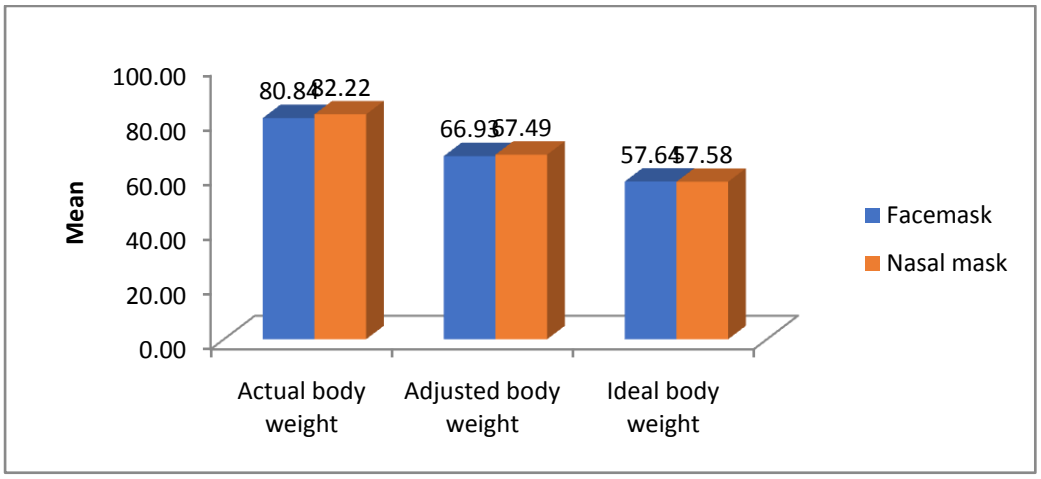


Figure 5: weight distribution of the patients.

Table 5: Height distribution of the patients.

	Facemask		Nasal mask		t	p-value
	Mean	SD	Mean	SD		
Height (cm)	164.16	7.11	164.28	6.80	-0.080	0.936

The mean height in the facemask group was 164.16±7.11 cm and in the nasal mask group was 164.28±6.80cm. Both groups were statistically similar and did not show any difference. P-value 0.936

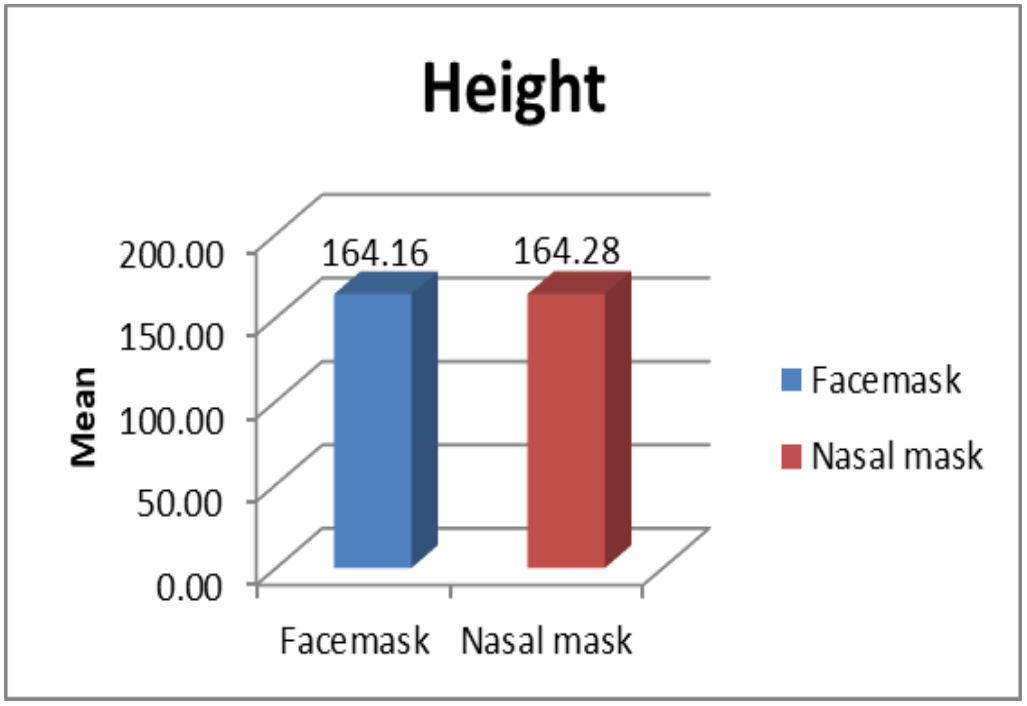


Figure 6: Height distribution of the patients.

Table 6: BODY MASS INDEX (BMI) of the patients.

	Facemask		Nasal mask		t	p-value
	Mean	SD	Mean	SD		
BMI (kg/m^2)	29.97	2.77	30.40	2.40	-0.777	0.439

The mean BMI in the facemask group was 29.97±2.77 kg/m^{2}and in the nasal mask group was 30.40±2.40 kg/m^2.The difference in mean BMI of patients in both groups was statistically insignificant with a p-value of 0.439

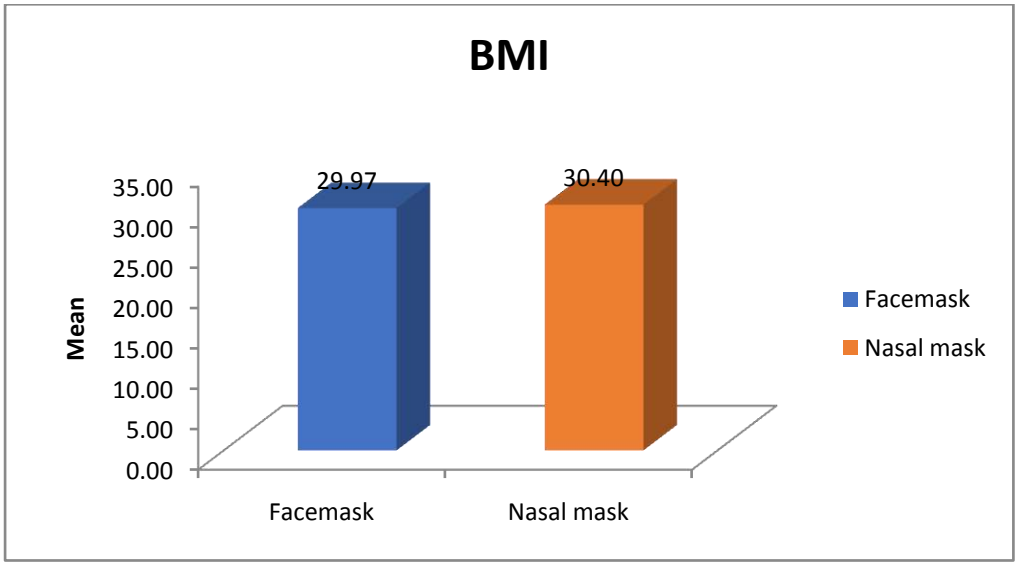


Figure 7 BODY MASS INDEX (BMI) of the patients.

Table 7: Mean neck circumference of the patients.

	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
Neck circumference (cm)	35.44	3.56	36.23	3.43	-1.056	0.291

The mean neck circumference in the facemask group was 35.44±3.56 cm and in the nasal mask group was 36.23±3.43 cm. There were no statistical differences in mean Neck circumferences in both groups (p-value 0.291).

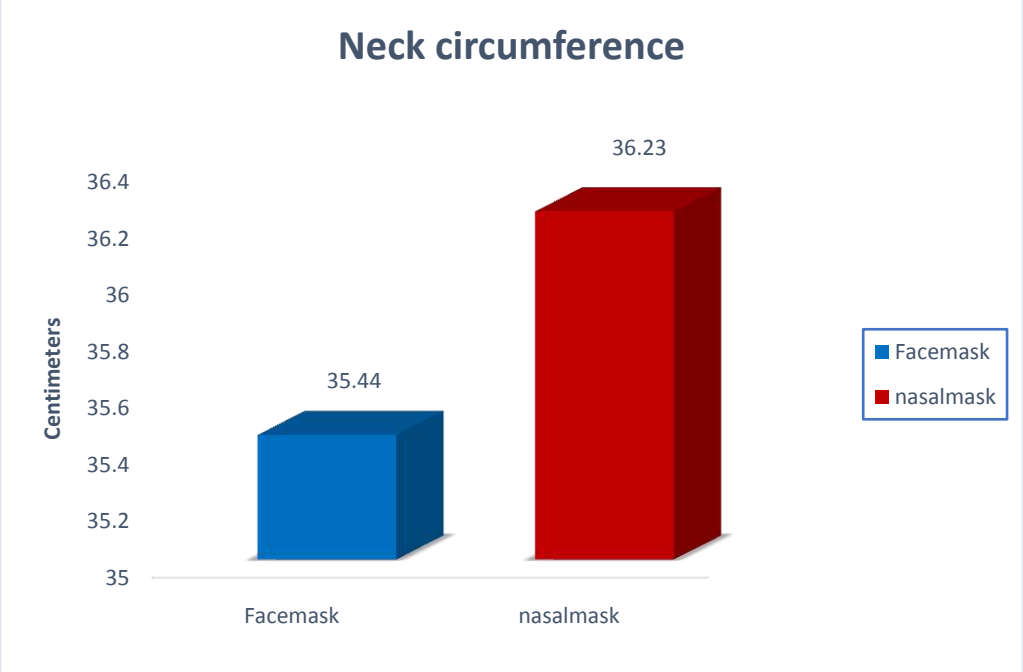


Figure 8: Mean neck circumference of the patients.

Table 8: STOP-BANG score of the patients.

		Facemask		Nasal mask		Total	Chi-square value	p-value
		No. of cases	%age	No. of cases	%age			
STOP-BANG	0	14	31.1%	8	17.8%	22	8.78	0.067
	1	11	24.4%	10	22.2%	21		
	2	13	28.9%	9	20.0%	22		
	3	4	8.9%	15	33.3%	19		
	4	3	6.7%	3	6.7%	6		
Total		45	100.0%	45	100.0%	90		

Out of 45 patients in the facemask group, 31.0% of patients had a STOP-BANG score of 0/8, 24.4% had a score of 1/8, 28.9% had a score of 2/8, 8.9% had a score of 3/8 and 6.7% had a score of 4/8, whereas in 45 patients belonging to the nasal mask group 31.0% of patients had a STOP-BANG score of 0/8, 24.4% had score 1/8, 28.9% had a score 2/8, 8.9% had a score of 3/8 and 6.7% had a score of 4/8. None of the patients in either group has a score of more than 4/8. STOP-BANG score of both groups was comparable and statistically insignificant with a p-value of 0.067

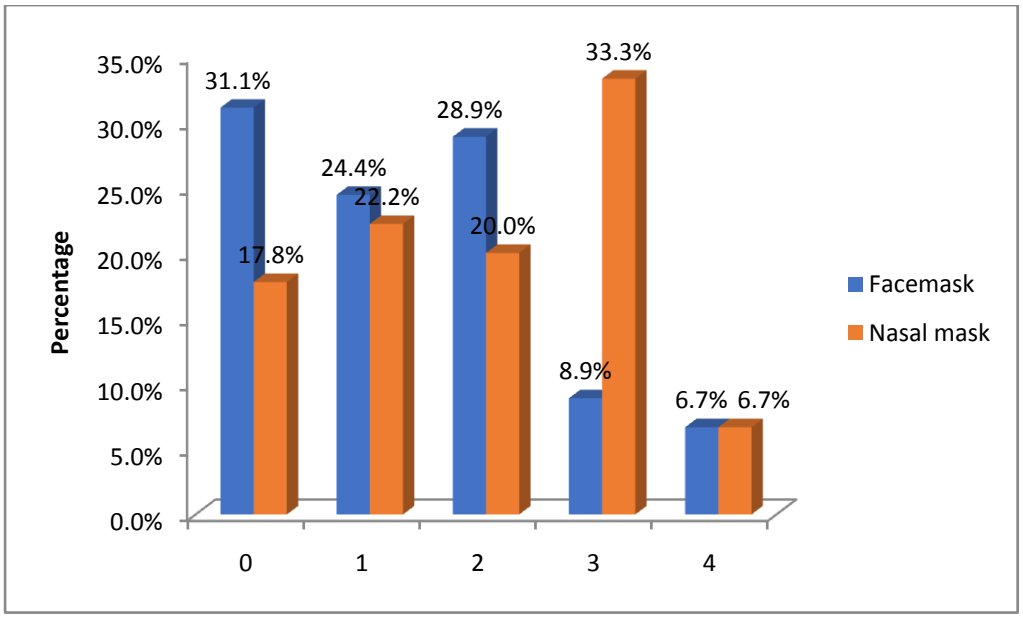


Figure 9: STOP-BANG score of the patients.

- **PARAMETERS OF STUDY**

1. EXPIRED TIDAL VOLUME

Table 9: Trends in mean expired tidal volume per breath amongst both groups.

Group	Facemask		Nasal mask		t	p-value
	Mean	SD	Mean	SD		
Vte_1 (ml)	431.91	48.16	450.80	54.92	-1.735	0.086
Vte_2 (ml)	435.53	48.34	454.58	55.16	-1.742	0.085
Vte_3 (ml)	435.82	49.04	455.98	55.99	-1.817	0.073
Vte_4 (ml)	437.42	49.59	456.49	55.68	-1.715	0.090
Vte_5 (ml)	438.33	50.32	456.67	55.87	-1.636	0.105
Vte_6 (ml)	437.76	50.41	456.80	55.65	-1.701	0.092
Vte_7 (ml)	438.33	49.85	457.18	56.04	-1.685	0.095
Vte_8 (ml)	438.07	50.13	457.27	55.77	-1.718	0.089
Vte_9 (ml)	437.84	49.99	457.07	55.89	-1.720	0.089
Vte_10 (ml)	438.00	50.00	457.00	55.80	-1.701	0.092

Table 10: Mean expired tidal volume amongst groups.

	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
Vte(ml)	436.90	49.50	455.98	55.64	-1.715	0.086

The mean expired tidal volume during the first breath was 431.91±48.16 ml in the face mask group and 450.80±54.92 ml in the nasal mask group (p-value 0.086), subsequently, the mean tidal volume during the tenth breath was 438.00±50.00 ml in face mask group and 457.00±55.80 ml in nasal mask group(p-value 0.092). However, the tidal volume increased with successive breaths but was not statistically significant. The mean expired tidal volume of all the breaths was slightly better in the nasal mask (455.98±55.64 ml) group as compared to the facemask group (436.90±49.50ml) but was not statistically significant (p-value 0.086).

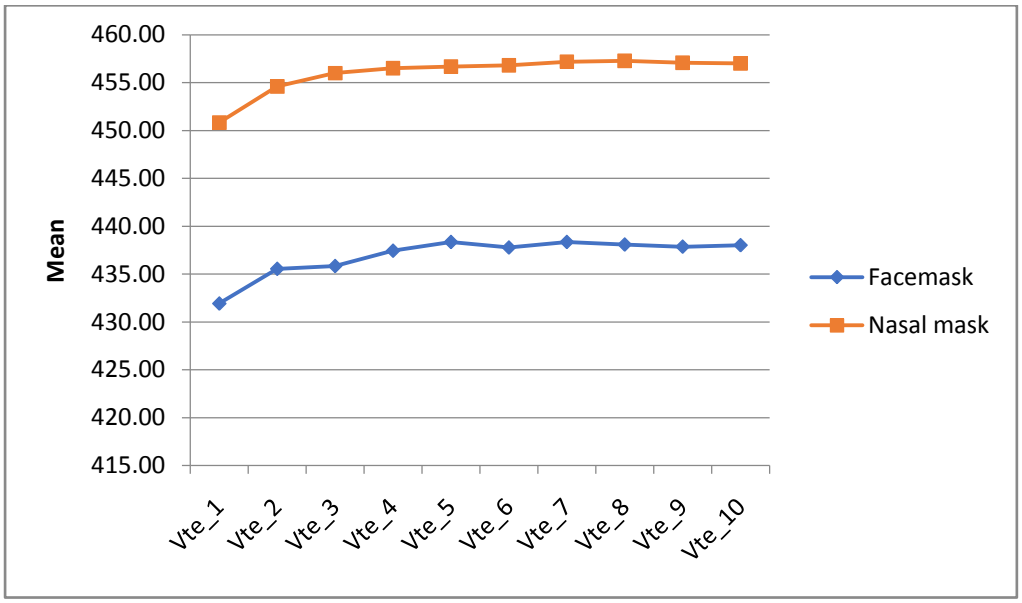


Figure 10: Trends in mean expired tidal volume per breath amongst both groups.

2. PEAK INSPIRATORY PRESSURE

Table 11: Trends in mean peak Inspiratory pressure per breath among both the groups.

Peak inspiratory pressure(PIP)	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
PIP_1(cmH_2O)	20.73	3.07	15.40	1.39	-7.812	0.001
PIP_2(cmH_2O)	20.20	3.19	14.82	1.48	-7.793	0.001
PIP_3(cmH_2O)	19.80	3.16	14.84	1.26	-7.628	0.001
PIP_4(cmH_2O)	20.47	5.21	14.80	1.47	-7.621	0.001
PIP_5(cmH_2O)	19.76	2.98	14.87	1.44	-7.692	0.001
PIP_6(cmH_2O)	19.71	3.06	14.73	1.45	-7.589	0.001
PIP_7(cmH_2O)	19.64	3.08	14.62	1.50	-7.611	0.001
PIP_8(cmH_2O)	19.69	3.02	14.62	1.43	-7.711	0.001
PIP_9(cmH_2O)	19.69	3.03	14.58	1.44	-7.737	0.001
PIP_10(cmH_2O)	19.67	3.19	14.60	1.44	-7.694	0.001

Table 12: Mean Peak inspiratory pressure.

	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
PIP(cmH_2O)	19.94	3.05	14.79	1.38	-7.734	0.001

There was a statistically significant difference in mean peak inspiratory pressure in both groups during the entire study period. After successive breaths, the peak inspiratory pressure decreased thus indicating an improvement in ventilation with low peak inspiratory pressures.

The mean peak inspiratory pressure during the first breath was 20.73±3.07cmH_2O in the face mask group and 15.40±1.39cmH_2O in the nasal mask group with a p-value of 0.001, subsequently the mean

peak inspiratory pressure during the tenth breath was 19.67±3.19cmH_2O in face mask group and 14.60±1.44cmH_2O in nasal mask group which showed a statistically significant difference between the two groups. The mean peak inspiratory pressure for all the breaths in the nasal mask group was 14.79±1.39cmH_2O showing a statistically significant difference against the facemask group 19.94±3.05cmH_2O(p-value 0.001).

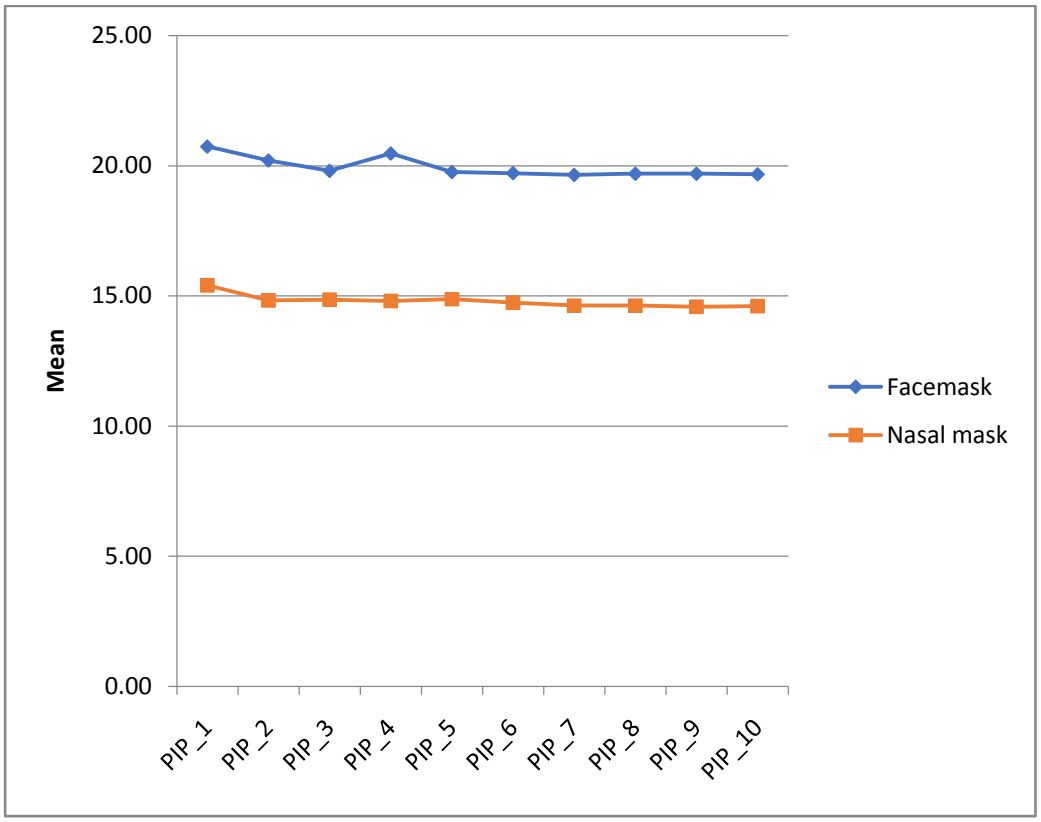


Figure 11: Trends in mean Peak inspiratory pressure per breath amongst both the group.

3. END-TIDAL CARBONDIOXIDE

Table 13: Trends in mean End-tidal carbon dioxide ($EtCO_2$) per breath amongst both the group.

	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
$ETC0_2$_1	30.02	2.54	29.98	1.91	-0.624	0.533
$ETC0_2$_2	30.16	2.62	29.87	2.05	-1.169	0.242
$ETC0_2$_3	30.02	2.41	29.69	2.02	-1.038	0.299
$ETC0_2$_4	30.38	2.42	29.87	1.94	-1.728	0.084
$ETC0_2$_5	30.16	2.35	29.89	1.94	-1.058	0.290
$ETC0_2$_6	30.16	2.30	29.91	1.93	-0.968	0.333
$ETC0_2$_7	30.18	2.25	30.04	1.89	-0.703	0.482
$ETC0_2$_8	30.18	2.31	29.89	1.89	-1.209	0.227
$ETC0_2$_9	30.16	2.23	29.96	1.93	-0.779	0.436
$ETC0_2$_10	30.24	2.24	29.82	2.43	-1.020	0.308

Table 14: Mean $EtCO_2$ amongst both the groups.

	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
$ETCO_2$	30.16	2.27	29.89	1.84	-1.385	0.166

The mean end-tidal carbon dioxide difference was statistically insignificant in both groups for the entire study period. The mean $EtCO_2$ in the nasal mask group was 29.89±1.84 against 30.16±2.27 in the facemask group. The p-value was 0.166.

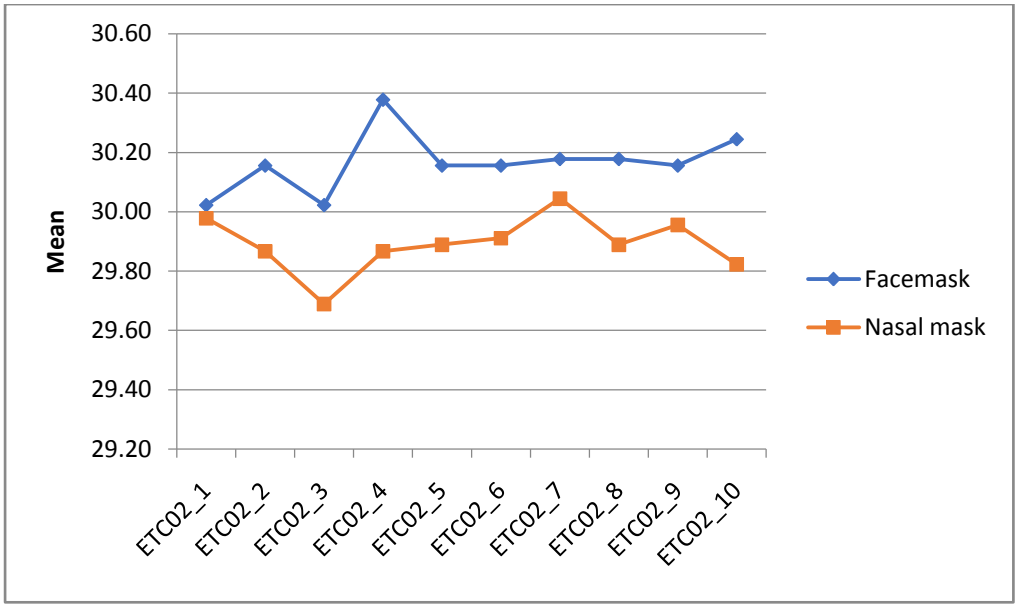


Figure 12: Trends in mean End-tidal carbon dioxide ($EtCO_2$) per breath amongst both the group.

4. OXYGEN SATURATION (SpO_2)

Table 15: Trends in mean oxygen saturation per breath amongst both the groups.

	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
SPO2_1(%)	99.42	1.18	99.53	1.41	-1.035	0.301
SPO2_2(%)	99.58	0.97	99.62	1.23	-1.250	0.211
SPO2_3(%)	99.56	1.14	99.62	1.23	-1.049	0.294
SPO2_4(%)	99.56	1.12	99.67	1.07	-1.275	0.202
SPO2_5(%)	99.64	0.93	99.76	0.80	-1.134	0.257
SPO2_6(%)	99.64	1.05	99.73	0.81	-0.319	0.750
SPO2_7(%)	99.67	0.93	99.64	1.11	-0.248	0.804
SPO2_8(%)	99.69	0.87	99.60	1.21	-0.199	0.843
SPO2_9(%)	99.69	0.87	99.60	1.21	-0.199	0.843
SPO2_10(%)	99.69	0.87	99.62	1.19	-0.227	0.820

Table 16: Mean oxygen saturation amongst both the group.

	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
SPO2 (%)	99.61	0.97	99.64	1.04	-0.730	0.466

The difference in mean oxygen saturation between both groups was statistically insignificant (p-value 0.466). The mean spo_2 during the entire study period was 99.61±0.97 % in the facemask group and 99.64±1.04 % in the nasal mask group.

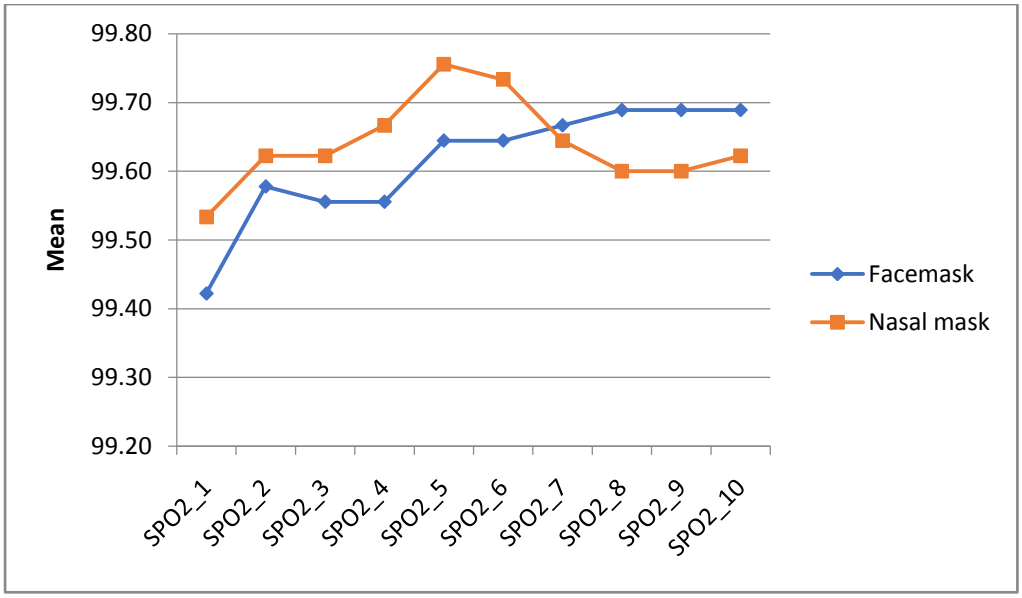


Figure 13: Trends in mean oxygen saturation per breath amongst both the group.

- **PLATEAU PRESSURE**

Table 17: Trends in mean plateau pressure per breath amongst both the group.

	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
PLATEAU_1(cmH_2O)	17.18	2.59	12.64	1.35	-7.716	0.001
PLATEAU_2(cmH_2O)	16.62	2.58	11.96	1.38	-7.653	0.001
PLATEAU_3(cmH_2O)	16.62	2.50	12.13	1.22	-7.736	0.001
PLATEAU_4(cmH_2O)	16.69	2.64	12.16	1.28	-7.663	0.001
PLATEAU_5(cmH_2O)	16.69	2.56	12.00	1.28	-7.707	0.001
PLATEAU_6(cmH_2O)	16.58	2.62	11.89	1.21	-7.761	0.001
PLATEAU_7(cmH_2O)	16.51	2.63	11.96	1.17	-7.729	0.001
PLATEAU_8(cmH_2O)	16.53	2.64	11.91	1.20	-7.724	0.001
PLATEAU_9(cmH_2O)	16.56	2.59	11.89	1.19	-7.751	0.001
PLATEAU_10(cmH_2O)	16.60	2.62	11.89	1.19	-7.757	0.001

Table 18: Mean plateau pressure amongst both the group.

	Facemask		Nasal mask		Z	p-value
	Mean	SD	Mean	SD		
PLATEAU pressure(cmH_2O)	16.66	2.56	12.04	1.21	-7.777	0.001

There was a statistically significant difference in mean plateau pressure in both groups during the entire study period. The mean plateau pressure during the first breath was 17.18±2.59cmH_2O in the facemask group and 12.64±1.35cmH_2O in the nasal mask group with a p-value of 0.001, subsequently the mean peak inspiratory pressure at the tenth breath was 16.60±2.62cmH_2O in face mask group and 11.89±1.19cmH_2O in nasal mask group which was a statistically significant difference between the two groups. The mean of all the breaths in the nasal mask group was 12.04±1.21cmH_2O against 16.66±2.56cmH_2O in the facemask group with a p-value of 0.001

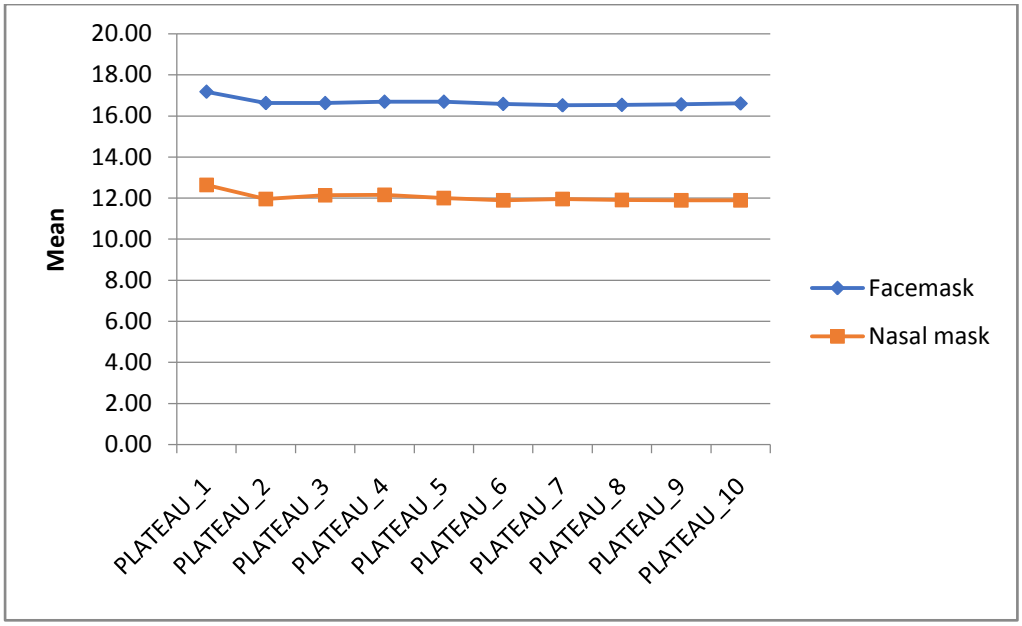


Figure 14: Trends in mean plateau pressure amongst both the group per breath.

DISCUSSION

Mask ventilation is a vital component of airway management during the induction of general anaesthesia. Obesity has been considered to be a risk factor for increased difficulty in airway management. Difficult mask ventilation has been defined as the inability of an unassisted anaesthesiologist to prevent or reverse signs of inadequate ventilation during positive pressure mask ventilation. DMV has an incidence of 1.5-7.8% in the general population[38]. Nasal continuous positive airway pressure (CPAP) is used to successfully treat obstructive sleep apnoea (OSA) as it provides a pneumatic splint and prevents upper airway collapse[9,15]. Various studies have compared the role of nasal and face masks in treating OSA using CPAP[14,15]. The majority of these studies have reported greater patient compliance and satisfaction, less respiratory difficulty during sleep, and a better sleep pattern using a nasal mask than a face mask**.** The mechanism of action of a nasal mask in providing patency of the upper airway appears to be similar in anaesthetized patients[39].

The present study was designed to compare the efficacy of face mask ventilation with nasal mask ventilation in obese patients (BMI> 25 kg/m^2) undergoing surgery under general anaesthesia.

The study was conducted in the Department of Anaesthesiology, Dayanand Medical College and Hospital, Ludhiana. 90 adult ASA I, II & III patients posted for surgery under general anaesthesia were enrolled and randomly allocated into two groups of 45 patients each. The technique for general anaesthesia was standardized in both groups. Patients in group A were ventilated with the facemask and patients in group B were ventilated with the nasal mask

Parameters of ventilation were noted for 10 consecutive breaths and compared in this study.

The primary findings of this study illustrate that ventilation with a nasal mask generated similar tidal volume when compared to face mask ventilation with significantly lower airway pressures i.e. peak inspiratory pressure and plateau pressure.

Both groups were statistically comparable regarding age, sex distribution, height, body weight, and body mass index. The groups were also comparable concerning ASA physical status and STOP-BANG score. In our study, we compared two techniques of mask ventilation, i.e. Nasal mask ventilation which provides ventilation predominantly through the nasal route, and face mask ventilation which provides ventilation through both the nasal as well as oral routes. Standard facemask ventilation technique is routinely practised in all anaesthesia procedures whereas nasal mask ventilation is not practised customarily. A few studies have been done to compare facemask ventilation and nasal mask ventilation for ventilation in different subsets of populations. However, limited data is available on the comparison of the efficacy of both techniques in the obese population posted for surgery under general anaesthesia.

In a sedated patient in the supine position, the soft palate and tongue fall back due to gravity and obstruct the pharyngeal airway[12]. This obstruction is worsened by neuromuscular blockade. During nasal mask ventilation, positive pressure is generated in the nasopharynx and this pressure gradient between the nasopharyngeal and oropharyngeal cavities can overcome the effect of gravity. The soft palate and the tongue are pushed forward and the upper airway is kept patent. A study by Liang et al. demonstrated that mouth-to-nose breathing is more effective than mouth-to-mouth breathing in anaesthetized, apnoeic adult subjects without muscle paralysis. They hypothesized that the obstruction of the oropharynx by the tongue facilitates nasal ventilation by reducing the oral leak[18].

We used volume control ventilation in both groups to achieve a predetermined tidal volume delivery. The mean tidal volume in the nasal mask group was 455.98±55.64 ml against 436.90±49.60ml in the facemask group. Although both mask interfaces adequately ventilated patients with equivalent amounts of tidal volume, the nasal mask group had a little higher mean expired tidal volume than the face mask group, and the difference was not statistically significant ($p>0.05$).

Our results are similar to a study published by Aghadavoudi et al on nasal mask versus facemask ventilation in the adult obese population (BMI>25Kg/m^2), the researcher observed no significant difference between the expired tidal volume in both groups. In the facemask group, the expired tidal volume in the 2nd minute was 547.2±72.9ml and 530.8±56.1ml in the nasal mask group (p-value >0.05)[3].

In a similar study by Aghadavoudi et al. on paediatric patients the mean expiratory tidal volume in the face mask group was 117.728.6 ml against 123.932.3 ml in the nasal mask group for three consecutive breaths. However, no statistically significant difference was observed at any time and both the mask interfaces ventilated the patients with a comparable amount of tidal volume (P value > 0.05).Paediatric patients have bigger tongues and have adenotonsillar hypertrophy. This causes more airway blockade in the event of facemask ventilation than nasal mask ventilation as the nasal channel remains patent[29].

A study conducted by Liang et al. reported that the expired tidal volume was greater with nasal mask ventilation as compared to combined oral-nasal mask ventilation. Nasal mask ventilation had a median tidal volume of 264.8 ml, whereas the combined oral–nasal mask ventilation had a median of 65.6 ml (P <0.05)[16]. The researchers observed gross outward movement of the cheeks during inspiration with combined oral–nasal mask ventilation, whereas this was rarely observed with nasal mask ventilation. The difference in study results could also be due to the different approaches used by the researchers. They used a separate nasal and oral mask for combined oro-nasal ventilation with separate flow/CO_2 sensors and ventilation was performed without muscle paralysis. Similarly, Kapoor et al observed a statistically significant rise in the expired tidal volume on changing over to nasal mask ventilation. The mean Tidal volume observed during the study period was 498.7±150.7ml in the face mask group and 532.3±118.3ml in the nasal mask group (p<0.05). This difference in tidal volume delivery could be due to potential air leaks around the face mask due to reduced contact between the cheeks and mask, whereas with nasal

mask ventilation, the only contact of the mask is with the maxillary plane, thus preventing an excessive gas leak[11].

Obese patients often have marked increases in pleural pressure; therefore, the recommended ceiling in airway pressure of 30 cm H_2O can be safely exceeded in such patients. Increased airway pressure can be concomitant with some complications including increased air insufflations into the stomach and increased risk of regurgitation and aspiration of gastric contents. A study published by Lee et al. done on 180 mechanically ventilated patients in an intensive care unit (ICU) reported obese patients (BMI>30kg/m^2) had significantly higher mean peak inspiratory pressures (34 cmH_2O in obese vs. 30 cm H_2O in non-obese, $p < 0.0002$) and mean plateau pressures (23 cmH_2O in obese vs. 20 cmH_2O in non-obese, $p < 0.0001$). They also observed that a significantly greater percentage of obese patients had plateau pressures >30 cmH_2O[23].

We encountered lower airway pressures (peak inspiratory pressure and plateau pressure) in the nasal mask group as compared to the face mask group. The joint between the upper and lower jaw becomes unstable in an anaesthetised patient. The pressure applied to the facemask in trying to ensure a good seal often displaces the mandible posteriorly, causing upper airway obstruction[40]. Moreover, some anaesthesiologists' hands may not be large enough to perform an adequate jaw thrust while adding pressure to the facemask to ensure a tight seal, which however may not be the case while using a nasal mask[2,16].

High pressure applied to the nasal mask will not displace the lower jaw posteriorly because no unstable joint is pressured. Higher pressure is a way to overcome the mechanical obstruction occurring in the airway, which correlates with the mechanisms of creating a higher pressure in the oral cavity by a face mask to provide sufficient ventilation. The mean PIP in the nasal mask group was 14.79±1.34 cmH_2O and in the face mask group was 19.94±3.05 cmH_2O ($p <0.05$). The mean plateau pressure in the nasal mask group was 12.04±1.21 cmH_2O and in the face mask group was 16.66±5.56 cmH_2O ($p<0.05$). We observed

successive decreases in PIP and plateau pressure moving from the first to tenth breath in both groups depicting an improvement in ventilation quality.

Liang et al. compared 50 patients undergoing general anaesthesia who were initially ventilated by a combined oral and nasal mask and subsequently by a nasal mask. It was reported that the nasal mask provided significantly more efficient ventilation compared to oral-nasal mask ventilation with lower airway pressures. The PIP with nasal mask ventilation (16.7±2.7 cm H_2O) was significantly lower than that with combined oral–nasal mask ventilation (24.5±4.7 cm H_2O; P <0.05)[16].

In contrast to our study, Kapoor et al observed higher airway pressures (PIP of 9.2±3.9 cm H_2O in the facemask group and 11.8±3.4 cm H_2O in the nasal mask group respectively. p<0.001) in edentulous patients. Face mask ventilation of the edentulous patient is often difficult as ineffective seating of the standard mask to the face prevents the attainment of an adequate air seal[11].

Our results are consistent with the results of Aghadavoudi et al. who compared nasal mask vs facemask ventilation in patients with BMI>25 kg/m^2. It was a randomised trial done on 70 patients undergoing orthopaedic procedures under general anaesthesia. The researchers found that airway pressures were less in the nasal mask group. The mean maximum airway pressure in the 2nd minute after ventilation was significantly higher (p<0.001) in the face mask group (14.6±1.6 cmH_2O.) than in the nasal mask group (12.4±1.7 cmH_2O.)[3]. In contrast in a study on paediatric patients done by the same group of researchers, no difference was observed in maximal airway pressure between the groups in three consecutive breaths (P-value > 0.05)[29].

End-tidal CO_2 ($EtCO_2$) is a measure of metabolism, perfusion, and ventilation. It is seen as an objective marker of ventilation status and is a reliable indicator of respiratory status. In our study, End-tidal carbon dioxide ($EtCO_2$) recorded in both groups for 10 successive breaths did not show any statistically significant difference. $EtCO_2$ in both groups was in the normal range indicating that patients were ventilated adequately by both the nasal mask and face mask (nasal mask -

29.89±1.84 ml, facemask- 30.16±2.27 ml, p>0.05). Aghadavoudi O et al. however observed higher $EtCO_2$ in the nasal mask group (31.4±3.5 mmHg) than in the facemask group (29.5±4 mmHg) p<0.05, which suggested better ventilation with a nasal mask. However, $EtCO_2$ was within the normal range in both groups[3].

However in a study conducted by Liang et al., the Volume of carbon dioxide ($VbCO_2$) removed during nasal mask ventilation was significantly larger than that during combined oral–nasal mask ventilation. The $VbCO_2$ during nasal mask ventilation (median5.0 ml, interquartile range 3.4–8.8 ml) was significantly larger than that during combined oral–nasal mask ventilation (median 0.0 ml, interquartile range 0.0–0.4 ml; P <0.05)[16].

Oxygen saturation was recorded during the study period along with other parameters of ventilation. It is one of the quantitative measures related to the quality of ventilation. This measure is defined as the percentage of haemoglobin, which is saturated with oxygen. However, it did not show any statistically significant difference between both groups. The mean SpO_2 in the nasal mask group was 99.64±1.04 % and 99.61±0.97 % in the facemask group (p>0.05). None of the subjects experienced significant oxygen desaturation during the study period.

In contrast, Aghadavoudi et al. in their study on obese patients (BMI>25 kg/m^2) observed that the SpO_2 level in the 2nd minute after initiating mask ventilation was higher in the nasal mask group (97.6+/-1.7%) than the face mask group (95+/-3%) which is statistically significant (p<0.001). They further mentioned that under similar conditions in both groups, when Spo2 is higher in one group, it can be an indication that more oxygen is being delivered to the patient, probably showing more efficient ventilation when using a nasal mask[3].

Similar to our study Kapoor et al. reported that they were able to deliver reasonable ventilation with both mask interfaces in all the cases and that none of the patients suffered blood oxygen desaturation of less than 95%[11].

Thus, we noted that an anaesthetised apnoeic obese patient under general anaesthesia could be effectively ventilated using a nasal mask. In our study ventilation with a nasal mask was associated with lower airway pressures as compared to a facemask while delivering a comparable tidal volume.

There are certain limitations to our study.1) one of the limitations of our study was the inability to achieve adequate blinding of the observer 2) Difference between the set and expired tidal volume was not considered during the study. It can help quantify the amount of leak during mask ventilation.

SUMMARY AND CONCLUSION

This prospective study was conducted in the Department of Anaesthesiology, Dayanand Medical College and Hospital, Ludhiana on 90 obese patients of ASA grade I, II, and III of either gender undergoing surgery under general anaesthesia. Patients were assigned to one of the two groups of 45 patients each according to computer-generated random numbers. The technique of general anaesthesia was standardized in both groups. Group A was ventilated with a facemask and group B was ventilated with a nasal mask. Ventilatory parameters i.e. tidal volume, peak inspiratory pressure, plateau pressure, oxygen saturation and end-tidal carbon dioxide were noted for ten consecutive breaths.

The following conclusions were drawn –

1. Tidal volume generated was greater in the nasal mask group as compared to the face mask group, though the difference was not statistically significant.
2. Airway pressures i.e. Peak inspiratory pressure and plateau pressure were significantly lower in the nasal mask group as compared to the facemask group.
3. End-tidal carbon dioxide was comparable in both groups showing effective ventilation in both the groups
4. Oxygen saturation measured was comparable in both groups and none of the patients during the study experienced oxyhemoglobin desaturation.

Hence, we conclude that nasal mask ventilation is an effective method for ventilating obese apnoeic paralyzed adult patients during induction of general anaesthesia. It can be effectively used as an alternative to facemask ventilation during general anaesthesia induction.

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Sr. No.	MRD. No	Name	Age	AGE GROUP	Sex	Diagnosis	ASA Grade	Surgery proposed	Date of Admission	Date of surgery	Height	Height (cm)	Actual body weight	Adjusted body weight	Ideal body weight	BMI	STOP-BANG SCORE	Neck circumference	Previous Anaesthesia and surgery	Drug allergy	Pallor
1	1049272	RK	51	4	M	CHOLELITHIASIS	I	LAP CHOLECYSTECTOMY	11-03-21	12-03-21	5'8"	172.7	90	77	68	30.2	2	39	N	N	N
2	1050392	PJ	29	1	M	POLYP	I	FESS	13-03-21	14-03-21	5'10"	177.8	98	83	73	31	1	37	N	N	N
3	1014010	AS	43	3	F	NEPHROLITHIASIS	I	PCNL	22-03-21	23-03-21	5'5"	165.1	85	68	57	31.2	3	39	N	N	N
4	967144	SR	45	3	M	MASS ICJ	II	RIGHT HEMICOLECTOMY	13-04-21	14-04-21	5'8"	172.7	98	80	68	32.9	3	39.5	N	N	N
5	1068953	PY	24	1	F	INFERTILITY	I	DIAGNOSTIC HYSTEROSCOPY	21-04-21	21-04-21	5'3"	160	70	59	52	27.3	0	35	N	N	N
6	1108266	BW	37	2	F	APPENDICITIS	II	LAP APPENDECTOMY	20-04-21	21-04-21	5'3"	160	85	65	52	33.2	2	40	N	N	N
7	1115658	HS	24	1	M	FOREIGN BODY NOSE	II	FOREIGN BODY REMOVAL	03-06-21	04-06-21	5'9"	175.2	98	82	71	31.9	0	37	N	N	N
8	1116028	p	28	1	F	CHOLELITHIASIS	I	LAP CHOLECYSTECTOMY	17-06-21	18-06-21	5'4"	162.5	76	63	55	28.8	0	33	N	N	N
9	1125263	SR	57	4	F	MYOMA	II	TLH	21-06-21	22-06-21	5'2"	157.4	78	61	50	31.5	2	38	N	N	N
10	1128933	AP	19	1	F	PAROTID ADENOMA	I	PAROTIDECTOMY	28-06-21	29-06-21	5'5"	165.1	72	63	57	26.4	0	34	N	N	N
11	7813	RITU	39	2	F	CHOLELITHIASIS	I	LAP CHOLECYSTECTOMY	05-07-21	06-07-21	5'4"	162.5	85	67	55	32.2	3	40	N	N	N
12	1135537	SR	51	4	F	FIBROID UTERUS	II	TLH	12-07-21	13-07-21	5'2"	157.4	75	60	50	30.2	2	39	N	N	N
13	1138248	AK	55	4	F	FIBROID UTERUS	II	TLH WITH BSO	16-07-21	17-07-21	5'4"	162.5	79	64	55	29.9	2	38	N	N	N
14	943797	SH	60	4	F	POCO ILLEOSTOMY	III	STOMA CLOSURE	20-07-21	21-07-21	5'3"	160	83	65	52	31.4	4	42	LAPAROTOMY WITH ILLEOSTOMY UNDER GA	N	N
15	1140084	CS	32	2	M	FRACTURE CLAVICLE	I	ORIF	22-07-21	23-07-21	5'7"	170.1	76	67	62	26.2	1	35	N	N	N
16	1142163	S	31	2	M	CHOLELITHIASIS	I	LAP CHOLECYSTECTOMY	29-07-21	29-07-21	5'6"	167.7	75	66	59	26.9	2	36	N	N	N
17	1144945	AK	62	5	F	VENTRAL HERNIA	II	IPOM	28-07-21	30-07-21	5'0"	152.4	80	59	45	34.4	4	42	N	N	N
18	1145256	RG	41	3	F	FIBROID UTERUS	I	LAP MYOMECTOMY	30-07-21	31-07-21	5'2"	157.4	68	57	50	27.4	2	34	N	N	N
19	1146304	RK	32	2	M	CHOLELITHIASIS	I	LAP CHOLECYSTECTOMY	01-08-21	02-08-21	5'9"	175.2	86	77	71	28	1	32	N	N	N
20	1147132	R	55	4	M	INGUINAL HERNAI	I	ETEP	02-08-21	03-08-21	5'6"	167.7	81	68	59	28.8	2	36	N	N	N
21	1146887	DS	48	3	M	CHOLELITHIASIS	I	LAP CHOLECYSTECTOMY	02-08-21	03-08-21	5'8"	172.7	79	70	64	26.5	2	32	N	N	N
22	1165329	MK	46	3	F	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	01-08-21	04-08-21	5'2"	157.4	76	60	50	30.6	3	38	N	N	N
23	1146732	L	58	4	M	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	04-08-21	05-08-21	5'8"	172.7	89	74	64	29.8	3	38	N	N	N
24	1138236	BS	53	4	M	RENAL CALCULI	II	PCNL	16-08-21	17-08-21	5'9"	175.2	95	78	66	30.9	2	35	N	N	N
25	1160987	P	27	1	F	PRIMARY INFERTILITY	II	HYSTEROSCOPY	15-09-21	15-09-21	5'2"	157.4	80	62	50	32.3	3	41	N	N	N
26	1169206	BR	45	3	F	GIST	III	LAPROSCOPIC GIST EXCISION	25-09-21	27-09-21	5'1"	154.9	72	57	48	30	2	36	N	N	N
27	1184655	H	23	1	F	BREAST LUMP	II	BREAST LUMP EXCISION	04-10-21	05-10-21	5'2"	157.4	78	61	50	31.5	1	41	N	N	N
28	1188312	H	38	2	F	FIBROID UTERUS	II	TLH	12-10-21	13-10-21	5'3"	160	86	66	52	33.6	4	38	N	N	N
29	1189300	N	60	4	M	UMBLICAL HERNIA	III	ETEP	11-10-21	13-10-21	5'4"	162.5	88	71	59	33.3	3	39	EXPLORATORY LAPAROTOMY UNDER GA	N	N
30	1194568	AS	43	3	M	INGUINAL HERNIA	II	ETEP	19-10-21	20-10-21	5'8"	172.7	92	78	68	30.8	1	32	N	N	N
31	1194404	RK	50	3	F	CHOLELITHIASIS ,FIBROID	II	LAP CHOLECYSTECTOMY, TLH	20-10-21	21-10-21	5'2"	157.4	78	61	50	31.5	1	38	N	N	N
32	1211089	SS	32	2	F	INCISIONAL HERNIA	II	IPOM	02-11-21	03-11-21	5'2"	157.4	80	62	50	31.5	3	38	EXPLORATORY LAPAROTOMY UNDER GA	N	N
33	1212022	JK	49	3	F	CHOLELITHIASIS	III	LAP CHOLECYSTECTOMY	09-11-21	10-11-21	5'0"	152.4	70	55	45	30.1	1	38	N	N	N
34	1204502	VG	51	4	M	ACUTE APPENDICITIS	I	LAP APPENDECTOMY	09-11-21	10-11-21	5'9"	175.2	90	76	66	29.3	1	34	N	N	N
35	570596	N	41	3	F	FIBROID UTERUS	II	TLH	19-11-21	20-11-21	5'3"	160	88	68	55	34.4	2	38	N	N	N
36	1212996	RJ	44	3	F	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	24-11-21	25-11-21	5'4"	162.5	76	63	55	28.8	0	35	N	N	N
37	162910	J	40	2	M	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	01-12-21	02-12-21	5'7"	170.1	88	75	66	30.1	1	32	N	N	N
38	1219321	RB	47	3	F	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	06-12-21	07-12-21	5'5"	165.1	83	70	61	30.4	3	41	LSCS UNDER SAB	N	N
39	1220101	SK	59	4	M	INGUINAL HERNIA	III	ETEP	07-12-21	08-12-21	5'6"	167.7	86	73	64	30.6	3	36	EXPLORATORY LAPAROTOMY UNDER GA	N	N
40	1222154	YJ	49	3	M	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	10-12-21	11-12-21	5'9"	175.2	98	82	71	31.9	3	39	N	N	N
41	1223646	RJ	56	4	F	HERNIA	III	TAR	13-12-21	15-12-21	5'3"	160	88	67	52	34.4	4	42	LSCS UNDER SAB	N	N
42	1209972	SD	34	2	M	POCO ILLEOSTOMY	II	STOMA CLOSURE	17-12-21	18-12-21	5'8"	172.7	85	75	68	28.5	1	32	EXPLORATORY LAPAROTOMY UNDER GA	N	N
43	1159018	VG	56	4	F	UTERINE MYOMA	II	TLH	18-12-21	19-12-21	5'5"	165.1	86	69	57	31.6	1	36	N	N	N
44	1226994	GK	49	3	F	PERFORATION PERITONITIS	II	EXPLORATORY LAPAROTOMY	20-12-21	21-12-21	5'1"	154.9	65	55	48	27.1	0	32	LSCS UNDER SAB	N	N
45	1209135	PS	48	3	M	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	21-12-21	22-12-21	5'7"	170.1	96	78	66	34.2	3	42	N	N	N
46	403563	JS	39	2	M	CSOM	II	TYMPANOPLASTY	06-01-22	07-01-22	5'9"	175.2	110	86	71	35.8	2	38	N	N	N
47	1236313	SK	46	3	F	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	09-01-22	10-01-22	5'2"	157.4	86	64	50	34.7	1	40	N	N	N
48	91088	s	43	3	f	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	24-01-22	25-01-22	5'5"	165.1	92	71	57	33.8	0	38	N	N	N
49	1245665	G	40	2	F	EPIPHORA	I	ENDO DCR	30-01-22	31-01-22	5'6"	167.7	75	66	59	26.7	0	32	N	N	N
50	1246212	RK	45	3	F	ILLEOCEACAL MASS	II	EXPLORATORY LAPAROTOMY	30-01-22	31-01-22	5'3"	160	78	63	52	30.5	1	32	N	N	N

Icterus	Cyanosis	Pulse rate	Edema	clubbing	lymph node	Respiratory rate	Vte_1	Vte_2	Vte_3	Vte_4	Vte_5	Vte_6	Vte_7	Vte_8	Vte_9	Vte_10	Vte	PIP_1	PIP_2	PIP_3	PIP_4	PIP_5	PIP_6	PIP_7	PIP_8	PIP_9	PIP_10	PIP	ETCO2_1	ETCO2_2	ETCO2_3	ETCO2_4	ETCO2_5	ETCO2_6
N	N	86	N	N	N	18	450	455	449	460	470	466	480	466	465	462	462.3	20	20	18	17	17	18	17	18	17	17	17.9	28	27	28	29	27	27
N	N	65	N	N	N	20	490	495	500	499	510	511	500	510	508	510	503.3	22	19	20	20	20	19	19	19	20	19	19.7	29	28	29	29	29	29
N	N	86	N	N	N	18	420	428	428	430	428	431	430	431	433	433	429.2	15	14	14	15	14	14	14	15	14	14	14.3	28	28	27	27	28	28
N	N	98	N	N	N	20	510	515	515	515	518	520	525	520	520	518	517.6	12	13	12	12	13	13	12	12	12	12	12.3	28	29	29	29	28	28
N	N	79	N	N	N	20	390	395	393	395	390	400	392	392	393	393	393.3	13	14	14	13	13	13	12	12	12	12	12.8	30	32	30	30	32	31
N	N	78	N	N	N	16	400	392	392	405	405	402	408	410	410	410	403.4	20	18	17	17	17	18	17	17	17	17	17.5	30	32	32	32	32	32
N	N	86	N	N	N	16	500	510	508	515	520	520	525	525	525	525	517.3	19	18	19	19	18	18	19	18	18	19	18.5	25	26	27	27	27	27
N	N	62	N	N	N	18	400	405	405	402	400	400	410	400	400	405	402.7	19	18	17	18	20	20	18	18	18	18	18.4	28	28	28	27	27	27
N	N	92	N	N	N	18	410	408	408	408	407	410	409	410	409	409	408.8	14	13	14	14	14	14	14	14	14	14	13.9	30	32	30	30	30	30
N	N	86	N	N	N	15	410	415	413	417	417	418	417	418	418	418	416.1	13	12	12	12	11	11	11	11	11	11	11.5	30	28	28	30	30	30
N	N	83	N	N	N	18	420	425	430	431	430	428	430	430	430	430	428.4	15	14	15	15	15	16	15	15	15	15	15	28	25	26	25	25	25
N	N	88	N	N	N	18	390	391	390	392	392	390	390	391	391	391	390.8	18	17	18	18	18	18	18	18	18	18	17.9	28	28	26	30	28	28
N	N	78	N	N	N	18	405	410	405	405	405	400	402	405	405	405	404.7	22	22	21	20	21	21	21	21	21	21	21.1	32	32	32	32	32	32
N	N	86	N	N	N	19	430	432	430	430	432	432	432	432	430	430	431	14	13	14	14	14	14	14	13	13	13	13.6	25	25	25	25	25	25
N	N	88	N	N	N	20	420	422	410	420	423	425	425	425	427	427	422.4	26	24	25	24	24	24	24	24	24	24	24.3	30	32	32	32	30	30
N	N	86	N	N	N	16	410	415	416	415	420	418	415	418	420	420	416.7	20	18	20	20	18	18	18	20	20	18	19	28	30	28	30	30	31
N	N	92	N	N	N	18	480	485	490	490	492	490	490	492	490	490	488.9	16	15	15	15	16	16	15	15	15	15	15.3	32	32	32	30	31	32
N	N	86	N	N	N	18	370	380	375	377	375	372	375	375	374	375	374.8	20	18	20	20	18	18	18	19	19	19	18.9	30	32	30	32	30	30
N	N	76	N	N	N	18	510	500	510	505	505	506	505	505	504	505	505.5	20	18	18	18	18	20	19	19	19	19	18.8	25	25	25	25	26	26
N	N	86	N	N	N	18	450	450	455	445	450	451	450	452	450	450	450.3	14	13	14	13	13	13	13	13	13	13	13.2	32	33	32	32	33	33
N	N	90	N	N	N	18	450	455	456	456	456	458	458	458	458	454	455.9	20	19	18	18	18	18	18	18	18	18	18.3	33	32	33	32	33	32
N	N	86	N	N	N	20	400	399	400	405	400	400	401	401	400	400	400.6	18	17	18	17	17	17	17	17	17	17	17.2	25	25	26	25	25	25
N	N	95	N	N	N	19	500	498	499	500	499	499	500	500	500	500	499.5	16	15	16	16	16	16	16	16	16	16	15.9	30	32	30	30	30	30
N	N	86	N	N	N	18	520	518	518	518	519	518	519	519	519	519	518.7	16	17	15	15	15	15	15	15	15	15	15.3	30	28	28	30	30	30
N	N	62	N	N	N	18	400	405	403	400	402	400	402	400	400	400	401.2	24	23	23	23	23	22	23	22	22	22	22.7	30	32	32	31	31	31
N	N	110	N	N	N	18	380	382	382	381	380	380	380	380	380	380	380.5	16	15	15	14	15	15	15	15	15	15	15	28	30	28	30	28	28
N	N	86	N	N	N	18	400	398	398	397	397	397	398	398	398	398	397.9	20	18	20	19	19	19	19	19	19	19	19.1	30	31	30	30	31	30
N	N	88	N	N	N	18	450	455	458	458	458	458	458	459	458	458	457	16	17	16	16	16	16	16	16	16	16	16.1	28	27	27	27	27	27
N	N	86	N	N	N	18	475	480	482	480	484	480	484	485	484	485	481.9	16	17	16	16	15	15	15	15	15	15	15.5	26	27	27	27	27	27
N	N	88	N	N	N	18	500	505	508	508	510	508	505	508	506	510	506.8	18	19	18	18	19	18	18	18	18	18	18.2	30	32	30	32	32	32
N	N	86	N	N	N	18	400	405	408	408	410	410	410	410	409	409	407.9	22	21	22	21	21	21	21	21	21	21	21.2	30	32	30	32	32	32
N	N	86	N	N	N	19	390	400	410	408	410	409	409	409	408	408	406.1	17	16	16	16	16	16	15	16	16	16	16	32	32	30	30	32	32
N	N	110	N	N	N	19	350	360	362	362	362	362	363	365	365	365	361.6	13	12	13	12	12	12	12	12	12	12	12.2	28	28	28	30	30	30
N	N	81	N	N	N	18	510	512	520	522	520	520	520	520	522	522	518.8	14	15	15	15	15	15	15	15	15	15	14.9	30	30	30	31	30	30
N	N	68	N	N	N	18	430	432	430	432	432	432	433	433	435	435	432.4	23	24	23	23	23	23	23	23	23	23	23.1	32	30	30	32	30	32
N	N	72	N	N	N	16	480	490	492	510	510	510	510	510	510	510	503.2	18	17	17	17	17	17	17	17	17	17	17.1	32	30	30	30	30	30
N	N	78	N	N	N	18	500	505	508	508	508	508	508	508	508	508	506.9	16	15	16	16	16	16	16	16	16	16	15.9	32	30	30	30	30	30
N	N	86	N	N	N	18	560	570	572	572	572	572	572	573	573	572	570.8	16	17	16	16	15	15	15	15	15	15	15.5	30	31	30	30	30	31
N	N	99	N	N	N	18	490	495	500	500	501	502	502	500	500	500	499	15	14	14	14	14	14	14	15	14	14	14.2	32	30	32	32	32	32
N	N	93	N	N	N	18	545	550	555	556	555	556	558	558	558	558	554.9	14	13	14	13	13	13	13	13	13	13	13.2	30	30	32	32	32	30
N	N	86	N	N	N	18	430	433	432	432	432	430	432	432	432	432	431.7	18	17	17	17	17	17	17	18	17	17	17.2	28	28	30	30	30	30
N	N	110	N	N	N	20	500	510	512	512	512	513	513	512	515	515	511.4	16	15	15	15	15	15	15	15	15	15	15.1	26	25	26	26	26	26
N	N	98	N	N	N	18	440	451	452	452	452	451	452	452	451	451	450.4	15	14	14	14	15	14	14	14	14	14	14.2	28	30	28	28	28	28
N	N	88	N	N	N	16	360	365	368	368	368	367	368	367	367	367	366.5	20	20	19	19	19	19	19	19	19	19	19.2	30	30	28	29	29	29
N	N	110	N	N	N	16	530	533	533	535	535	534	534	534	534	534	533.6	19	18	18	18	18	18	18	18	18	18	18.1	25	24	25	25	25	25
N	N	72	N	N	N	18	550	550	551	555	555	554	554	554	554	554	553.1	26	25	25	26	25	26	25	25	25	25	25.3	23	24	24	24	24	25
N	N	86	N	N	N	16	410	412	412	410	412	412	412	412	410	412	411.4	28	28	28	28	27	28	28	28	28	30	28.1	32	30	32	30	32	30
N	N	86	N	N	N	18	480	479	479	479	480	480	480	480	480	480	479.7	16	15	15	15	15	15	15	15	15	15	15.1	28	30	28	28	28	28
N	N	76	N	N	N	16	440	442	442	442	442	440	442	441	441	441	441.3	16	16	15	15	15	15	15	15	15	15	15.2	30	32	33	33	33	33
N	N	86	N	N	N	16	410	412	410	415	415	415	415	415	415	415	413.7	25	25	24	24	24	24	24	24	24	24	24.2	30	32	33	33	32	32

ETC02_7	ETC02_8	ETC02_9	ETC02_10	ETCO2	SPO2_1	SPO2_2	SPO2_3	SPO2_4	SPO2_5	SPO2_6	SPO2_7	SPO2_8	SPO2_9	SPO2_10	SPO2	PLATEAU_1	PLATEAU_2	PLATEAU_3	PLATEAU_4	PLATEAU_5	PLATEAU_6	PLATEAU_7	PLATEAU_8	PLATEAU_9	PLATEAU_10	PLATEAU	GROUP
28	28	27	26	27.5	100	100	100	100	100	100	100	100	100	100	100	16	17	16	17	17	17	16	15	17	17	16.5	Facemask
29	29	29	29	28.9	100	100	100	100	100	100	100	100	100	100	100	22	18	18	18	18	18	18	18	18	18	18.4	Facemask
28	27	27	27	27.5	100	100	100	100	100	100	100	100	100	100	100	13	12	13	13	12	12	13	13	12	12	12.5	Nasal mask
29	29	28	29	28.6	100	100	100	100	100	100	100	100	100	100	100	11	12	11	11	10	10	11	10	11	11	10.8	Nasal mask
31	32	32	32	31.2	99	100	100	100	100	100	100	100	100	100	99.9	12	11	12	11	11	11	11	11	10	10	11	Nasal mask
32	32	32	32	31.8	100	100	100	100	100	100	100	100	100	100	100	18	17	15	15	15	15	15	15	15	15	15.5	Facemask
26	26	26	26	26.3	99	99	100	99	100	100	100	100	100	100	99.7	16	15	15	15	16	15	15	15	15	15	15.2	Facemask
29	27	27	28	27.6	100	100	100	100	100	100	100	100	100	100	100	16	15	16	15	15	16	15	15	15	15	15.3	Facemask
30	30	30	30	30.2	100	100	100	100	100	100	100	100	100	100	100	11	10	11	11	10	11	11	11	11	11	10.8	Nasal mask
30	30	30	20	28.6	100	100	100	100	100	100	100	100	100	100	100	10	9	10	10	10	10	11	10	10	10	10	Nasal mask
25	25	25	25	25.4	100	100	100	100	100	100	100	100	100	100	100	11	10	11	11	11	11	11	11	11	11	10.9	Nasal mask
28	28	28	28	28	100	100	100	100	100	100	100	100	100	100	100	15	16	16	16	16	15	15	15	15	15	15.4	Facemask
32	32	32	32	32	100	100	100	100	100	100	100	100	100	100	100	16	15	15	16	16	16	16	16	16	16	15.8	Facemask
25	25	25	25	25	100	100	100	100	100	100	100	100	100	100	100	12	11	11	11	11	11	11	11	11	11	11.1	Nasal mask
32	30	30	30	30.8	100	100	100	100	100	100	100	100	100	100	100	17	16	17	17	17	16	17	17	17	17	16.8	Facemask
30	30	30	30	29.7	100	100	100	100	100	100	100	100	100	100	100	16	15	16	16	16	15	15	15	16	16	15.6	Facemask
31	30	30	30	31	100	100	100	100	100	100	100	100	100	100	100	12	11	11	12	12	12	12	11	11	11	11.5	Nasal mask
30	30	30	30	30.4	100	100	100	100	100	100	100	100	100	100	100	16	17	16	16	16	16	16	17	17	17	16.4	Facemask
26	26	26	30	26	100	100	100	100	100	100	100	100	100	100	100	16	16	16	16	17	17	17	17	17	17	16.6	Facemask
33	32	32	32	32.4	100	100	100	100	100	100	100	100	100	100	100	10	11	11	10	10	10	10	10	10	10	10.2	Nasal mask
32	32	32	32	32.3	100	100	100	100	100	100	100	100	100	100	100	17	17	17	16	17	17	17	17	17	17	16.9	Facemask
25	25	26	25	25.2	100	100	100	100	100	100	100	100	100	100	100	15	16	16	15	15	15	15	15	15	15	15.2	Facemask
30	30	30	30	30.2	100	100	100	100	100	100	100	100	100	100	100	14	13	14	13	13	13	13	13	13	13	13.2	Nasal mask
30	30	30	30	29.6	100	100	100	100	100	100	100	100	100	100	100	12	11	12	11	11	11	11	11	11	11	11.2	Nasal mask
30	30	31	31	30.9	100	100	100	100	100	100	100	100	100	100	100	18	18	17	18	18	18	18	18	18	18	17.9	Facemask
30	30	30	30	29.2	100	100	100	100	100	100	100	100	100	100	100	12	13	12	12	12	12	12	12	12	12	12.1	Nasal mask
30	30	30	30	30.2	100	100	100	100	100	100	100	100	100	100	100	16	17	17	17	17	17	16	17	17	17	16.8	Facemask
27	27	27	28	27.2	100	100	100	100	100	100	100	100	100	100	100	14	15	14	14	14	14	14	14	14	14	14.1	Nasal mask
27	27	27	27	26.9	100	100	100	100	100	100	100	100	100	100	100	15	14	14	14	14	13	13	13	13	13	13.6	Nasal mask
32	32	32	32	31.6	100	100	100	100	100	100	100	100	100	100	100	16	17	16	16	16	16	16	16	16	16	16.1	Facemask
32	32	33	32	31.7	100	100	100	100	100	100	100	100	100	100	100	18	17	18	17	17	17	17	17	17	17	17.2	Facemask
32	32	32	32	31.6	100	100	100	100	100	100	100	100	100	100	100	15	14	14	14	14	14	14	14	14	14	14.1	Nasal mask
30	30	30	30	29.4	100	100	100	100	100	100	100	100	100	100	100	11	10	10	11	11	10	10	10	10	10	10.3	Nasal mask
30	30	31	30	30.2	100	100	100	100	100	100	100	100	100	100	100	12	13	13	13	13	13	13	13	13	13	12.9	Nasal mask
32	32	32	32	31.4	100	100	100	100	100	100	100	100	100	100	100	19	20	20	20	20	20	20	20	20	20	19.9	Facemask
30	30	30	30	30.2	100	100	100	100	100	100	100	100	100	100	100	15	14	14	14	14	14	14	14	14	14	14.1	Facemask
31	30	31	30	30.4	100	100	100	100	100	100	100	100	100	100	100	14	13	13	13	13	13	13	13	13	13	13.1	Nasal mask
31	31	30	31	30.5	100	100	100	100	100	100	100	100	100	100	100	13	12	12	12	12	12	12	12	12	12	12.1	Nasal mask
32	32	32	32	31.8	99	98	98	98	98	99	99	98	98	99	98.4	11	10	11	11	11	11	11	11	11	11	10.9	Nasal mask
32	30	32	32	31.2	100	100	100	100	100	100	100	100	100	100	100	12	11	11	11	11	11	11	11	11	11	11.1	Nasal mask
30	30	30	30	29.6	100	100	100	100	100	100	100	100	100	100	100	14	14	13	13	13	13	13	13	13	13	13.2	Facemask
26	26	26	26	25.9	100	100	100	100	100	100	100	100	100	100	100	13	13	13	13	13	13	13	13	13	13	13	Nasal mask
28	28	28	28	28.2	100	100	100	100	100	100	100	100	100	100	100	13	12	12	12	12	12	12	12	12	12	12.1	Nasal mask
29	29	29	29	29.1	100	100	100	100	100	100	100	100	100	100	100	16	16	16	16	16	16	16	16	16	16	16	Facemask
25	25	26	26	25.1	100	100	100	100	100	100	100	100	100	100	100	16	15	15	15	15	15	15	15	15	15	15.1	Facemask
25	25	25	25	24.4	98	99	99	99	99	100	100	100	100	100	99.4	23	22	22	22	22	22	22	22	22	22	22.1	Facemask
30	32	30	32	31	98	98	99	99	99	99	99	99	99	99	98.8	25	24	24	24	24	24	24	24	24	24	24.1	Facemask
28	28	28	28	28.2	98	99	99	99	100	100	100	100	100	100	99.5	13	13	12	12	12	12	12	12	12	12	12.2	Nasal mask
33	33	33	33	32.6	100	100	100	100	100	100	100	100	100	100	100	14	13	13	13	13	13	13	13	13	13	13.1	Facemask
32	32	32	32	32	98	99	98	98	98	98	98	98	98	98	98.1	20	20	19	19	19	19	19	19	19	19	19.2	Facemask

51	1249488	SK	54	4	F	BREAST MASS	II	MRM	06-02-22	07-02-22	5'4"	162.5	80	65	55	30.3	1	38	N	N	N
52	1251323	GS	55	4	M	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	09-02-22	10-02-22	5'6"	167.7	86	70	59	30.6	0	36	N	N	N
53	1250866	AS	30	1	M	INGUINAL HERNIA	II	ETEP	11-07-22	12-02-22	5'7"	170.1	95	78	66	32.8	2	39	N	N	N
54	1185403	RK	27	1	M	ACUTE APPENDICITS	II	LAP APPENDECTOMY	11-02-2022	12-02-2022	5'4"	162.5	86	70	59	32.5	1	33	N	N	N
55	1252098	KK	35	2	F	CHOLELITHIASIS	I	LAP CHOLECYSTECTOMY	12-02-22	13-02-22	5'4"	162.5	75	63	55	28.4	3	33	N	N	N
56	977134	AS	33	2	M	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	13-02-22	14-02-22	5'5"	165.1	75	67	61	27.5	0	32	N	N	N
57	629890	RJ	56	4	F	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	15-02-22	16-02-22	5'2"	157.4	78	64	55	31.5	2	33	N	N	N
58	1251650	N	48	3	F	FIBROID UTERUS	II	TLH WITH BSO	15-02-22	16-02-22	5'1"	154.9	76	59	48	31.7	1	33	N	N	N
59	1008021	TL	46	3	F	INGUINAL HERNIA	II	ETEP	20-02-22	21-02-22	5'9"	175.2	88	75	66	28.6	0	32	N	N	N
60	1255405	RK	27	1	M	CSOM	II	MASTOIDECTOMY	22-02-22	23-02-22	5'7"	170.1	90	76	66	31.1	3	34	N	N	N
61	1150866	MK	25	1	M	CHOLELITHIASIS	I	LAP CHOLECYSTECTOMY	24-02-22	25-02-22	5'3"	160	67	58	52	26.2	1	32	N	N	N
62	1260274	U	53	4	F	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	27-02-22	28-02-22	5'2"	157.4	68	57	50	27.4	1	33	N	N	N
63	1260958	D	48	3	M	CHOLELITHIAISIS	II	LAP CHOLECYSTECTOM	30-03-22	01-03-22	5'7"	170.1	88	75	66	30.4	1	32	N	N	N
64	1249903	RJ	40	2	F	FIBROID UTERUS	II	TLH	30-02-2022	01-03-22	5'3"	160	90	67	52	35.1	3	41	N	N	N
65	1258831	NG	22	1	M	SINUSITIS	I	FESS	01-03-22	01-03-22	5'7"	170.1	76	70	66	26.2	0	31	N	N	N
66	246899	AB	48	3	F	ACUTE APPENDICITIS	I	LAP APPENDECTOMY	04-03-22	05-03-22	5'6"	167.7	76	66	59	27	0	31	N	N	N
67	1263366	AB	20	1	M	ACUTE APPENDICITS	II	LAP APPENDICECTOMY	09-03-22	09-03-22	5'8"	172.7	90	77	68	30.2	0	31	N	N	N
68	1204925	J	40	2	F	PERFORATION GALLBLADDER	II	LAP CHOLECYSTECTOMY	23-02-22	24-05-22	5'3"	160	72	60	52	28.1	0	30	N	N	N
69	1287579	SS	52	4	F	RECTAL MASS	II	RECTAL BIOPSY	24-04-22	25-04-22	5'4"	162.5	74	62	55	28	0	33	N	N	N
70	1292025	NA	49	3	F	AUB	II	TLH	22-04-22	23-04-22	5'1"	154.9	65	55	48	27.1	3	36	N	N	N
71	1292093	HS	37	2	M	SINUSITIS	II	FESS	22-04-22	23-04-22	5'7"	170.1	84	73	66	29	2	36	N	N	N
72	1195224	SK	29	1	M	INCOMPLETE ABORTION	I	D&C	23-04-22	24-04-22	5'4"	162.5	68	60	55	25.7	0	32	N	N	N
73	1295274	PK	46	3	M	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	28-04-22	29-04-22	5'9"	175.2	78	72	68	26.1	2	31	N	N	N
74	1296451	RM	49	3	F	FIBROID UTERUS	III	TLH	29-04-22	30-04-22	5'2"	157.4	86	64	50	34.7	2	32	N	N	N
75	1295970	J	24	1	F	INCOMPLETE ABORTION	I	D & C	29-04-22	29-04-22	5'5"`	165.1	82	67	57	30.1	0	32	N	N	N
76	1296409	SA	49	3	F	AUB	I	TLH	02-05-22	03-05-22	5'4"	162.5	74	62	55	28	2	37	N	N	N
77	1298235	CK	70	5	M	HYATID LIVER CYST	III	LAP CYSTECTOMY	04-05-22	05-05-22	5'8"	172.7	92	78	68	30.8	4	39	N	N	N
78	1299289	NS	56	4	M	POCO ILLEOSTOMY	II	STOMA CLOSURE	04-05-22	05-05-22	5'8"	172.7	88	76	68	29.5	3	41	N	N	N
79	1299303	MM	40	2	F	CHOLELITHIASIS	I	LAP CHOLECYSTECTOMY	06-05-22	06-05-22	5'3"	160	68	59	52	26.6	1	36	N	N	N
80	1298961	RG	52	4	F	POCO HERNIA REPAIR	III	HERNIA REPAIR	05-05-22	06-05-22	4'9'	144.8	76	58	45	36.3	4	42	ETEP	N	N
81	1302415	T	23	1	F	CBD INJURY	I	HEPATICOJEJUNOSTOMY	11-05-22	12-05-22	5'3"	160	68	59	52	26.6	2	31	OPEN CHOLECYSTECTOMY UNDER GA	N	N
82	665112	SG	43	3	F	B/L TUBOOVARIAN MASS	III	EXPLORATORY LAPAROTOMY	05-05-22	12-05-22	5'0"	152.4	65	53	45	28	2	39	N	N	N
83	1306128	SS	38	2	M	CHOLELITHIASIS	I	LAP CHOLECYSTECTOMY	19-05-22	19-05-22	5'7"	170.1	79	69	62	27.3	2	32	N	N	N
84	452123	GS	60	4	M	SOFT TISSUE MASS	III	LAP AND PROCEED	29-05-22	30-05-22	5'6'	167.7	88	73	64	31.3	3	39	N	N	N
85	1295300	JK	56	4	F	CHOLELITHIASIS	II	LAP CHOLECYSTECOMY	05-06-22	06-06-22	5"2"	157.4	77	61	50	31	3	40	N	N	N
86	1085414	SL	44	3	F	ADENEXAL MASS	II	STAGING LAPAROTOMY	13-06-22	14-04-22	5'4"	162.5	89	68	55	33.7	1	38	N	N	N
87	1095404	KK	36	2	F	AUB	II	ENDOMETRIAL BIOPSY	14-06-22	15-06-22	5'3"	160	75	61	52	29.3	0	32	N	N	N
88	1245667	M	29	1	F	CHOLELITHIASIS	II	LAP CHOLECYSTECTOMY	22-06-22	23-06-22	5'3"	160	75	61	52	29.3	0	33	N	N	N
89	1314027	S	37	2	F	CSOM	I	TYMPANOPLASTY	22-06-22	23-06-33	5'3"	160	74	64	57	27.1	0	31	N	N	N
90	159768	PS	47	3	M	UMBLICAL HERNIA	II	ETEP	23-06-22	24-06-22	5'6"	167.7	86	70	59	30.6	0	31	N	N	N

N	N	86	N	N	N	15	438	440	442	442	442	443	443	443	442	442	441.7	16	15	15	15	15	15	15	15	15	15	15	15.1	28	28	30	30	30	30
N	N	92	N	N	N	18	460	466	467	467	467	466	467	467	467	466	466	22	22	21	21	21	21	21	21	21	21	21	21.2	28	27	27	27	27	27
N	N	86	N	N	N	16	520	522	522	523	523	523	523	522	522	522	522.2	16	15	15	15	15	15	15	15	15	15	15	15.1	30	31	31	31	31	31
N	N	86	N	N	N	18	460	466	467	467	467	466	466	467	466	466	465.8	28	28	27	26	26	26	26	26	26	26	26	26.5	32	33	32	33	33	33
N	N	86	N	N	N	18	410	415	417	417	417	415	417	416	416	416	415.6	19	19	18	18	18	18	18	18	18	18	18	18.2	30	33	32	33	32	32
N	N	86	N	N	N	16	430	432	432	431	432	433	431	431	431	431	431.4	21	21	20	20	21	20	20	20	20	20	20	20.3	32	33	30	30	30	30
N	N	86	N	N	N	20	420	425	424	426	425	426	426	426	425	425	424.8	19	19	18	18	18	19	19	19	19	19	19	18.7	30	29	30	30	30	30
N	N	76	N	N	N	16	370	375	377	376	376	376	376	377	377	377	375.7	22	22	21	21	21	21	21	21	21	21	21	21.2	29	30	30	30	30	30
N	N	86	N	N	N	18	501	505	505	505	506	505	505	505	505	505	504.7	21	21	20	20	20	19	20	20	20	20	20	20.1	32	31	31	31	31	31
N	N	88	N	N	N	18	508	510	512	512	512	512	512	512	511	511	511.2	16	15	15	16	16	16	16	16	16	16	16	15.8	28	29	28	28	28	28
N	N	86	N	N	N	16	380	382	382	382	383	382	383	383	383	383	382.3	15	14	14	14	15	14	14	14	14	14	14	14.2	30	32	32	32	32	32
N	N	76	N	N	N	17	375	378	378	378	378	378	378	378	376	376	377.3	16	15	15	16	15	15	15	15	15	15	15	15.2	32	30	31	31	30	30
N	N	82	N	N	N	16	505	510	508	510	510	510	510	510	510	510	509.3	16	15	16	16	16	16	16	16	16	16	16	15.9	32	30	32	32	32	32
N	N	87	N	N	N	16	440	442	445	445	445	445	445	445	445	445	444.2	16	15	16	15	15	15	15	15	15	15	15	15.2	30	31	31	31	31	31
N	N	67	N	N	N	15	475	476	479	479	479	479	478	478	479	479	478.1	16	15	15	16	16	15	15	15	15	15	15	15.3	32	33	32	33	32	33
N	N	77	N	N	N	16	370	375	378	378	378	378	378	378	377	378	376.8	17	17	16	16	17	16	16	16	16	16	16	16.3	32	30	32	32	30	32
N	N	68	N	N	N	18	520	522	523	523	523	522	525	525	523	523	522.9	15	14	14	14	15	14	14	14	14	14	14	14.2	32	30	32	32	31	31
N	N	78	N	N	N	18	385	390	392	393	392	393	393	392	393	393	391.6	19	19	18	18	18	18	19	18	18	18	18	18.3	33	32	32	32	32	32
N	N	86	N	N	N	16	410	415	415	415	418	418	415	415	415	415	415.1	21	21	20	21	20	20	20	20	20	20	20	20.3	32	30	30	30	31	30
N	N	98	N	N	N	18	369	369	370	371	371	370	370	371	371	370	370.2	15	15	14	14	15	14	14	14	14	14	14	14.3	32	32	32	32	31	31
N	N	87	N	N	N	18	480	485	488	488	488	489	488	485	485	485	486.1	19	19	18	48	18	18	18	18	18	18	18	21.2	28	27	28	28	28	28
N	N	98	N	N	N	18	385	390	392	395	395	395	395	392	395	395	392.9	17	17	16	16	16	16	16	16	16	17	16	16.3	32	33	30	32	32	32
N	N	88	N	N	N	16	480	485	491	491	491	490	492	492	492	492	489.6	13	12	13	12	12	12	12	12	12	12	12	12.2	30	29	29	28	30	30
N	N	77	N	N	N	18	420	422	425	425	425	425	424	424	424	424	423.8	17	16	17	17	16	16	16	16	16	16	16	16.3	32	33	33	32	31	30
N	N	85	N	N	N	18	440	455	445	447	447	447	447	448	448	447	447.1	15	14	14	14	15	14	14	14	14	14	14	14.2	30	28	28	30	29	30
N	N	92	N	N	N	18	410	415	420	418	418	418	418	416	415	415	416.3	23	23	22	23	23	22	22	22	22	22	22	22.4	33	32	32	32	31	31
N	N	86	N	N	N	18	510	518	520	522	522	522	520	520	520	520	519.4	25	25	24	24	24	24	24	24	24	24	24	24.2	33	32	32	33	33	33
N	N	95	N	N	N	20	510	515	518	518	518	517	517	518	518	518	516.7	16	15	16	16	15	15	15	15	15	15	15	15.3	30	30	28	30	30	30
N	N	72	N	N	N	16	380	382	382	383	382	383	383	384	384	383	382.6	19	19	18	19	18	18	18	18	18	18	18	18.3	33	32	32	33	32	32
N	N	86	N	N	N	20	370	373	372	373	373	373	373	373	373	373	372.6	27	27	26	26	26	26	26	26	26	26	26	26.2	33	33	33	32	32	32
N	N	92	N	N	N	18	390	395	392	392	392	391	393	393	393	393	392.4	14	14	13	13	13	13	13	13	13	13	13	13.2	30	29	30	30	30	30
N	N	65	N	N	N	16	355	356	356	358	358	357	357	357	357	358	356.9	18	17	17	18	18	18	17	17	17	17	17	17.4	32	30	32	31	31	31
N	N	86	N	N	N	18	460	466	465	466	466	466	465	466	466	466	465.2	18	18	17	17	18	17	17	17	17	17	17	17.3	32	33	32	32	32	33
N	N	98	N	N	N	18	490	492	493	495	495	495	495	495	495	495	494	17	16	16	16	17	17	17	16	16	16	16	16.4	32	32	32	31	31	31
N	N	96	N	N	N	18	410	409	412	415	415	415	415	415	414	414	413.4	17	16	16	16	16	16	16	16	16	16	16	16.1	32	31	31	32	31	31
N	N	85	N	N	N	18	450	455	457	457	457	457	457	455	455	455	455.5	19	19	18	18	18	18	19	18	18	18	18	18.3	30	30	28	28	28	29
N	N	88	N	N	N	16	401	398	398	405	405	405	408	408	408	408	404.4	16	16	15	15	16	15	15	15	15	15	15	15.3	32	31	31	30	32	32
N	N	87	N	N	N	15	400	405	400	405	405	405	408	408	408	408	405.2	16	16	14	14	14	14	14	14	14	15	14.5	32	31	30	31	32	32	
N	N	79	N	N	N	16	418	418	419	419	425	425	425	425	420	420	421.4	16	16	15	16	16	15	15	15	15	15	15.4	32	33	33	32	32	32	
N	N	89	N	N	N	18	472	477	477	477	477	475	475	475	475	475	475.5	19	19	18	19	19	19	18	18	18	18	18.5	32	30	30	32	32	30	

30	30	30	30	29.6	100	100	100	100	100	100	100	100	100	100	100	13	12	12	12	12	12	12	12	12	12	12.1	Nasal mask
27	27	27	27	27.1	98	99	99	99	99	100	100	100	100	100	99.4	18	17	17	17	17	17	17	17	17	17	17.1	Facemask
31	31	31	31	30.9	99	100	100	100	100	100	100	100	100	100	99.9	14	13	13	13	13	13	13	13	13	13	13.1	Nasal mask
33	33	33	33	32.8	100	100	100	100	100	100	100	100	100	100	100	22	23	23	23	23	23	23	23	23	23	22.9	Facemask
32	32	32	32	32	100	100	100	100	100	100	100	100	100	100	100	16	15	15	15	15	15	15	15	15	15	15.1	Facemask
30	30	30	30	30.5	100	100	100	100	100	100	100	100	100	100	100	18	17	17	17	17	17	17	17	17	17	17.1	Facemask
30	30	30	30	29.9	100	100	100	100	100	100	100	100	100	100	100	16	15	15	16	16	16	16	16	16	15	15.6	Facemask
30	30	30	30	29.9	100	100	100	100	100	100	100	100	100	100	100	18	18	18	18	18	18	18	18	18	18	18	Facemask
31	31	31	31	31.1	100	100	100	100	100	100	100	100	100	100	100	18	17	17	17	17	17	17	17	17	17	17.1	Facemask
28	28	28	28	28.1	100	100	100	100	100	100	100	100	100	100	100	13	12	12	12	12	12	12	12	12	12	12.1	Nasal mask
32	32	32	32	31.8	100	100	100	100	100	100	100	100	100	100	100	12	11	12	11	11	11	11	11	11	11	11.2	Nasal mask
30	30	30	30	30.4	100	100	100	100	100	100	100	100	100	100	100	13	12	12	12	12	12	12	12	12	12	12.1	Nasal mask
32	32	32	32	31.8	100	100	100	100	100	100	100	100	100	100	100	13	12	12	12	12	12	12	12	12	12	12.1	Nasal mask
31	31	31	31	30.9	100	100	100	100	100	100	100	100	100	100	100	13	12	12	12	12	12	12	12	12	12	12.1	Nasal mask
32	32	32	32	32.3	100	100	100	100	100	100	100	100	100	100	100	13	12	12	12	12	12	12	12	12	12	12.1	Nasal mask
32	32	32	32	31.6	100	100	100	100	100	100	100	100	100	100	100	15	14	14	14	14	14	14	14	14	14	14.1	Facemask
31	31	31	31	31.2	100	100	100	100	100	100	100	100	100	100	100	13	12	12	12	12	12	12	12	12	12	12.1	Nasal mask
32	32	32	32	32.1	98	99	99	99	100	100	100	100	100	100	99.5	16	15	16	16	16	16	15	15	15	15	15.5	Facemask
30	30	30	30	30.3	98	98	98	99	99	98	98	98	98	98	98.2	18	17	17	17	17	17	17	17	17	17	17.1	Facemask
31	31	31	31	31.4	100	100	100	100	100	100	100	100	100	100	100	12	11	11	12	12	11	11	11	11	11	11.3	Nasal mask
28	28	28	27	27.8	100	100	100	100	100	100	100	100	100	100	100	16	15	15	15	15	15	15	15	15	16	15.2	Facemask
32	32	31	31	31.7	99	100	100	100	100	100	100	100	100	100	99.9	14	13	13	14	14	13	13	13	13	13	13.3	Facemask
30	29	30	30	29.5	100	100	100	100	100	100	100	100	100	100	100	11	10	11	11	11	10	10	10	10	10	10.4	Nasal mask
31	31	31	31	31.5	95	96	96	96	97	97	97	97	97	97	96.5	13	12	13	12	12	12	12	12	12	12	12.2	Nasal mask
30	30	30	30	29.5	100	100	100	100	100	100	100	100	100	100	100	13	12	12	12	12	12	12	12	12	12	12.1	Nasal mask
31	32	31	31	31.6	97	98	98	98	98	98	97	98	98	98	97.8	19	18	18	19	18	18	18	18	18	18	18.2	Facemask
32	32	32	32	32.4	96	96	95	95	96	96	97	97	97	97	96.2	21	20	20	22	20	20	20	20	20	20	20.3	Facemask
30	30	30	30	29.8	100	100	100	100	100	100	100	100	100	100	100	13	12	12	13	12	12	12	12	12	12	12.2	Nasal mask
32	32	32	32	32.2	100	100	100	100	100	100	100	100	100	100	100	16	15	15	15	16	15	15	15	15	15	15.2	Facemask
32	32	32	33	32.4	95	96	95	95	96	95	96	96	96	96	95.6	22	21	21	22	22	22	22	22	21	22	21.7	Facemask
30	29	29	30	29.7	100	100	100	100	100	100	100	100	100	100	100	11	10	11	11	10	10	10	11	11	11	10.6	Nasal mask
32	32	32	32	31.5	93	94	94	95	97	97	97	97	97	97	95.8	16	15	15	16	15	15	15	15	15	15	15.2	Nasal mask
33	33	33	33	32.6	100	100	100	100	100	100	100	100	100	100	100	15	14	15	14	14	14	14	14	14	14	14.2	Facemask
31	31	31	31	31.3	96	96	96	97	97	97	96	95	95	95	96	13	12	12	13	13	12	12	12	12	12	12.3	Nasal mask
31	31	31	33	31.4	100	100	100	100	100	100	100	100	100	100	100	13	12	12	13	12	12	12	12	12	12	12.2	Nasal mask
29	29	29	29	28.9	100	100	100	100	100	98	95	95	95	95	97.8	16	15	16	16	16	15	15	15	15	15	15.4	Nasal mask
32	32	32	32	31.6	100	100	100	100	100	100	100	100	100	100	100	12	12	12	12	12	12	12	12	12	12	12	Nasal mask
32	32	32	32	31.6	100	100	100	100	100	100	100	100	100	100	100	13	13	12	12	12	12	12	12	12	12	12.2	Nasal mask
32	32	32	32	32.2	100	100	100	100	100	100	100	100	100	100	100	13	12	13	13	12	12	12	12	12	12	12.3	Facemask
30	31	31	31	30.9	100	100	100	100	100	100	100	100	100	100	100	16	15	16	15	15	15	15	15	15	15	15.2	Facemask

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Date 05/11/23

The Principal,
DMC, Ludhiana.

Subject: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 29.10.2021 has approved the plan of thesis of **Gyan Singh**, a student of your college for **MD Anaesthesiology** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis

Evaluation of nasal mask vs face mask for ventilation during induction of general anaesthesia in obese patients.

Supervisor
Dr. Neeru Luthra
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Dept. of Anaesthesiology,
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Co-Supervisor

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The student has to submit the four copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

15. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*
16. *The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.*

EVALUATION OF NASAL MASK VS FACE MASK FOR VENTILATION DURING INDUCTION OF GENERAL ANAESTHESIA IN OBESE PATIENTS

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF MEDICINE

In

ANAESTHESIOLOGY

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

MARCH 2021

DR. GYAN SINGH

DEPARTMENT OF ANAESTHESIOLOGY
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ABSTRACT OF PLAN OF THESIS

Title	EVALUATION OF NASAL MASK VS FACE MASK FOR VENTILATION DURING INDUCTION OF GENERAL ANAESTHESIA IN OBESE PATIENTS
For the degree of	M.D. Anaesthesiology
Name of the candidate	Dr. GYAN SINGH
Supervisor	Dr. Neeru Luthra, Associate Professor, Department of Anaesthesiology, DMCH, Ludhiana
Co-supervisor	Dr. Shikha Gupta, Professor, Department of Anaesthesiology, DMCH, Ludhiana
Institution	Dayanand Medical College and Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Mask ventilation is a technique used for ventilation during induction of general anaesthesia. In supine position decreased upper airway tone and the effect of gravity on the soft palate and tongue leads to upper airway obstruction. This is further worsened in the obese patient. Upper airway obstruction in obese shares similarity with obstructive sleep apnea (OSA). Nasal CPAP has been successfully used in OSA as it provides a pneumatic splint and prevents upper airway collapse. With this background, the present study has been designed to evaluate the efficacy of nasal mask and face mask for ventilation during induction of general anaesthesia in obese patients.

Aim of Study: 1. To evaluate the efficacy of nasal mask ventilation against face mask ventilation in obese patients by comparing the Expired tidal volume. 2. To evaluate the Peak inspiratory pressure, end-tidal carbon dioxide, oxygen saturation and plateau pressure using the two techniques

Materials & methods: A prospective randomized study will be conducted on 90 patients posted for surgery under general anaesthesia, who will be divided into two groups. Facemask and nasal mask ventilation will be performed as per group allocation using standardized parameters of the ventilator. Respiratory parameters will be recorded simultaneously from both the nasal and facemasks and compared in the study.

Clinical Significance: Nasal mask ventilation is an important technique used for the treatment of obstructive sleep apnea as it provides a pneumatic splint and maintains patency of the upper airway. During the induction of general anaesthesia in obese patients, similar changes are encountered. Hence this study will help to compare the efficacy of nasal mask and facemask and find the better method of ventilation.

(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"EVALUATION OF NASAL MASK VS FACE MASK FOR VENTILATION DURING INDUCTION OF GENERAL ANAESTHESIA IN OBESE PATIENTS"** exist in the Department of Anaesthesiology at Dayanand Medical College and Hospital, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate himself under our supervision and guidance.

Supervisor

Neeru

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Place: Ludhiana.

Date: 14/3/2021.

APPROVAL PROFORMA
BY RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	Dr GYAN SINGH
Department	Anaesthesiology
Topic of Thesis	EVALUATION OF NASAL MASK VS FACE MASK FOR VENTILATION DURING INDUCTION OF GENERAL ANAESTHESIA IN OBESE PATIENTS
Likely date of appearing in PG examination	MAY-JUNE 2023
Date of enrollment	26th July 2020
Name of Head of Department	Dr. Dinesh Sood
1) Supervisor **2) Co-Supervisor**	Dr. Neeru Luthra Dr. Shikha Gupta
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
Dr. Harpreet Kaur (Professor & Head, Pathology)	Mr. R K Sharma (Legal Expert)
Dr. Jaspal Singh (Professor & Head, Surgery)	Dr. Ramit Mahajan (Associate Professor, Gastroenterology)
Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)	Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)
Dr. Gurpreet S Wander (Vice Principal)	Dr. Gurpreet S Wander (Vice Principal & Professor & Head, Cardiology)
	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / No

Dr. Sandeep Puri
Chairperson
Research Committee

Approved: Yes / ~~No~~

Prof. Arvind Malhotra
Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1	NAME OF THE CANDIDATE AND ADDRESS	DR GYAN SINGH A-10, DOLLY GUNJ, PORT BLAIR ANDAMAN AND NICOBAR ISLANDS
2	NAME OF THE INSTITUTE	DAYANAND MEDICAL COLLEGE AND HOSPITAL, LUDHIANA
3	COURSE OF STUDY AND SUBJECT	M.D. ANAESTHESIOLOGY
4	DATE OF ADMISSION OF COURSE	26th JULY 2020
5	TITLE OF THE TOPIC	EVALUATION OF NASAL MASK VS FACE MASK FOR VENTILATION DURING INDUCTION OF GENERAL ANAESTHESIA IN OBESE PATIENTS

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Mask ventilation is a vital component of airway management during the induction of general anaesthesia. Facemask ventilation includes two vital components; first, creating a complete seal between the mask and face to ensure no gas leaks, and the other, is maintaining patency of the upper airway. Factors like the presence of facial hair, obesity (BMI>25), lack of or missing teeth, age over 55 years, and a positive history of snoring are predictors for difficult ventilation[1]. The anticipation of difficult airway is important for effective airway management. A study conducted by Langron et al. reported the incidence of difficult ventilation to be 5 %, which is significantly correlated with difficult intubation[2].

Facemask ventilation of a patient after induction of anaesthesia is often inefficient due to decreased upper airway tone which leads to airway obstruction. The backward displacement of the tongue and soft tissue in a patient placed supine adds to the difficulty[3]. These effects are greater in obese patients where soft tissues such as the soft palate, lateral pharyngeal walls, tongue, and para pharyngeal fat pads are larger than that in normal-weight individuals[4,5]. Also, increased abdominal visceral fat is associated with lower lung volumes thus promoting a smaller and more collapse-prone upper airway[6].

To overcome the obstruction, higher airway pressures are required for adequate ventilation which may further lead to gastric insufflation resulting in vomiting and aspiration[6,7]. In cases in which inadequate facemask ventilation persists despite optimization strategies, alternative ventilation techniques can be helpful. Mechanism of upper airway obstruction under anaesthesia shares similarities with obstructive sleep apnea. Continuous positive airway pressure (CPAP) through a nasal mask has been used to successfully treat obstructive sleep apnea as it provides a pneumatic splint and prevents collapse of the upper airway[8]. As compared to facemask ventilation, no positive pressure is applied to the soft tissue of the tongue and mouth when using the nasal mask and the inspiratory tidal volume enters the airway

through a relatively rigid course in the nasal cavity. The gradient between nasopharynx and oropharynx can overcome the effect of gravity on the soft palate and tongue and thus maintain the patency of the upper airway[7].

Studies have been done to compare facemask versus nasal mask in adults. Yafen Liang in a study on apnoeic, non paralyzed, adult subjects during induction of general anaesthesia concluded that nasal mask ventilation was more effective than combined oral-nasal mask ventilation in removing the volume of carbon dioxide per breath. Along with ensuring more expiratory tidal volume, there is the advantage of a lower peak inspiratory during nasal mask ventilation. Based on the result of the study he suggested that nasal mask ventilation, rather than full facemask ventilation, should be considered during induction of anaesthesia[9]. In case of edentulous patients studied by Mukul Chandra nasal mask ventilation was found to be more effective as the air leak was lower due to a better seal between the nasal mask and face .The placement of the inferior end of nasal mask over the upper lip results in the contact of the mask with tissues with maxillary support, which is adequate in edentulous patients to provide appropriate seal[6]. Ventilation through nasal route leads to closure of oropharynx by the tongue and thus reducing the oral leak.

In another study done on unconscious apnoeic adults, mouth to nasal breathing was shown to be more effective than mouth to mouth breathing when the head is in a neutral position. The expired tidal volume during mouth to nasal breathing was significantly greater than those achieved during mouth to mouth breathing. These results suggest that direct ventilation via the subject's nose may result in more effective ventilation[10].

Omid aghadavoudi in a trial on obese patients compared ventilation using the standard mask ventilation with an anatomical nasal mask. The mean expiratory volume, mean SpO2, mean end-tidal CO2 (EtCO2), and mean airway pressure were measured, compared in both groups, and that ventilation was found to be more efficient with a nasal mask than a face mask[1].

Hence, we propose to study and evaluate the efficacy of nasal mask against facemask for ventilation during induction of general anaesthesia in obese patients.

6.2 REVIEW OF LITERATURE

Mask ventilation is a vital component of airway management during the induction of general anaesthesia. Obstructive sleep apnea shares commonalities with the upper airway obstruction occurring during induction of general anaesthesia. Pharynx is a collapsible segment of upper airway. The collapsibility of upper airway was studied by ***Peter R east wood*** who concluded that collapsibility of upper airway was directly associated with the depth of anaesthesia. Increasing the dose of propofol and subsequently the depth of anaesthesia was associated with increased collapsibility of the upper airway. This was attributed to the profound inhibition of genioglossus muscle activity[11,12]. The dose-related inhibition appeared to be a combined effect of depression of central respiratory output to upper airway dilator muscle and upper airway reflex. The major findings were that at each level of anesthesia the mean $pressure_{critical}$ for the group exceeded or was close to atmospheric pressure, implying that the pharynx is vulnerable to collapse during anesthesia, consistent with common clinical experience. Patients of all weight ranges who have a diagnosis of OSA are at increased risk of loss of the airway during procedures that require anesthetic sedation. In the majority of subjects, the upper airway collapsed at the level of the soft palate, and the site of collapse was unchanged by anaesthetic depth.

Nasal continuous positive airway pressure (CPAP) is used to successfully treat obstructive sleep apnea as it provides a pneumatic splint and prevents collapse of the upper airway. The results of a study conducted on nasal CPAP by ***Yandong Jiang*** suggested that application of nasal CPAP maintains upper airway patency and produced more effective ventilation than facemask CPAP. CPAP during induction of anaesthesia probably reduces atelectasis formation, and thereby maintains oxygenation. Indeed, the reduced “safety window” (the time taken to develop desaturation following breathing oxygen before induction of anaesthesia) is much reduced in obese patients, and this may be prolonged by PEEP or CPAP increasing lung

volume and increasing the reservoir of O_2 available for diffusion into the capillary blood. In another study by ***Sylvian Gander*** to find out the effects of positive end-expiratory pressure during induction of general anaesthesia and duration of nonhypoxic apnea in morbidly obese patients and concluded from the study that application of positive pressure increased nonhypoxic apnea duration by 50%[13].The possible reason was that nasal CPAP creates a positive pressure during both inspiration and expiration in the nasopharyngeal cavities which functions as a pneumatic splint that prevents upper airway obstruction by pushing the soft palate and the tongue forward and away from the posterior pharyngeal wall. Because the soft palate lies behind the tongue, the pressure gradient between the nasopharyngeal and oropharyngeal cavities pushes the soft palate and tongue forward, opening the airway. Nasal CPAP also increases lung volume and dilates the pharyngeal cavity[12].

A study by C K Chan showed that the nasal mask group had a significantly higher PaO2, a higher oxygenation ratio, arterial-alveolar ratio, lower respiratory rate and pulse rate showed that, in selected patients with acute hypercapnic respiratory failure, Bi-pap nasal mask ventilation can be used successfully[14]. There was a significant improvement in arterial oxygen tension. The differences suggest that Bi-pap nasal mask ventilation should be used early in the progression of respiratory failure.

In an observational study of 30 adult patients who had a BMI more than 30 mg/kg^2, undergoing general anesthesia for elective surgery demonstrated that the nasal mask ventilation facilitates non-invasive positive pressure ventilation, while allowing adequate oxygenation and ventilation for a variety of patients, including those who were edentulous, had a Mallampati score of 3, and a BMI above 30 kg/m^2. Using a hyperinflation bag attached to the nasal mask allows for continued positive pressure support and/or rescue ventilation during patient transport and recovery in the post anaesthesia care unit. The study also concluded that the rate of effective tidal volume was

significantly higher and the median expired tidal volume was significantly larger with nasal mask ventilation than with face masks[15].

Nasal mask was further compared with facemask by ***Yafen Liang*** in his study on normal adults by comparing the CO_2 removed per breath and expired tidal volume. They concluded that nasal mask ventilation was more effective than face mask ventilation in an apnoeic, non-paralyzed subject as the amount of CO_2 removed per breath was significantly larger in case of nasal ventilation as compared to facemask ventilation during induction of general anaesthesia[10].***Mukul Chandra*** compared the efficacy of nasal mask ventilation against facemask ventilation in edentulous patients and concluded that nasal mask ventilation is better than facemask ventilation as the air leak was lower due to better contact between the facial tissues and nasal mask in scenario of edentulous patients[6].

The study by ***Yandong jiang*** also concluded that ventilation delivered via nose is significantly more effective than that delivered via mouth in anesthetized apnoeic adults[10,16].

A study was conducted by ***Omid aghadavoudi*** and his colleagues on comparing nasal mask with facemask also concluded that ventilation with a nasal mask is more efficient than a face mask in patients with a BMI> 25 and is followed by a reduced amount of risk and complications[1]. Difficult mask ventilation may be related to narrowing of the space posterior to the tongue and the consequent airway obstruction. This phenomenon is similar to OSA by the posterior displacement of the tongue, uvula and epiglottis, justifying the fewer number of non-ventilation cases in the nasal mask group compared to the face mask group. One of the quantitative measures related to the quality of ventilation in this study, was SpO_2, which was significantly higher in the nasal mask group. Another result of the present study was the lower airway pressure in the nasal mask group. It indicated that increased pressure is a way to overcome the mechanical obstruction

occurring in the airway, which correlates with the mechanisms of creating a higher pressure in the oral cavity by a face mask to achieve comparable amount of tidal volume as compared to nasal mask. However, in obese patient tidal volume targets could be overestimated when calculated according to actual body weight and requiring higher airway pressures to achieve the respective tidal volume thus exposing these patients to harmful volutrauma and barotrauma. This exposure works directly against the lung-protective strategies that have been proven to improve mortality in patients with ARDS [17] . Adjusted body weight can be used as a better predictor to accurately define tidal volume targets.

Adjusted body weight is calculated as:

AjBW = IBW + 0.4(ABW – IBW)

Estimated Ideal body weight in (kg)[18] –

1. Males: IBW = 50 kg + 2.3 kg for each inch over five feet.
2. Females: IBW = 45.5 kg + 2.3 kg for each inch over five feet.

(ABW-actual body weight, AjBW-adjusted body weight, IBW-ideal body weight)

6.3 AIMS AND OBJECTIVES OF THE STUDY

PRIMARY OBJECTIVE: To compare the effectiveness of nasal mask ventilation versus face mask ventilation in obese patients by evaluating the expired tidal volume

SECONDARY OBJECTIVES: To compare the Peak inspiratory pressure, End-tidal carbon dioxide, Oxygen saturation and Plateau pressure using two techniques of ventilation.

7. MATERIALS AND METHODS

7.1 SOURCE OF DATA:

A randomized cross over study will be performed after approval of the Institutional ethics committee of Dayanand Medical College and hospital, Ludhiana. A total of 90 obese adult patients scheduled for surgery under general anaesthesia will be prospectively evaluated for inclusion in this study.

METHOD OF COLLECTION OF DATA:

A prospective, randomised, interventional study will be conducted on ASA I, II and III adults.90 patients will be recruited in the study and an equal number will be randomised using computer generated random numbers contained in sealed, sequentially numbered envelopes, which shall be opened by an independent anaesthesiologist.

Inclusion criteria:

1. Age >18 years
2. BMI > 25[19]

Exclusion criteria:

1. Patients having contraindication to drugs used in the study
2. Patients with maxillofacial trauma
3. Pregnancy
4. Edentulous
5. Bearded
6. Prognathia/retrognathia

GROUP ALLOCATION: A total 90 number of patients will be recruited for the study and will be allocated randomly using a computer-generated random number list to either of the two groups, using consecutively numbered opaque sealed envelopes.

1. Group A-Patients will be ventilated using facemask.
2. Group B-Patients will be ventilated using nasal mask.

PREANAESTHETIC CHECKUP

A thorough pre-anaesthetic check-up comprising of detailed history, comorbidities, and allergy to any drug being used will be conducted.

Patients will be explained about the study being conducted and written informed consent will be taken. Relevant investigations will be sent and reviewed. Demographic information including height, weight, BMI, age, sex, neck circumference, and STOP-BANG score will also be recorded.

ANAESTHESIA TECHNIQUE

All patients will be monitored using electrocardiography, heart rate, non-invasive blood pressure measurement, and peripheral oxygen saturation (SpO2) before induction of general anaesthesia. Appropriate mask size for the best fit would be determined by keeping the mask at the nasal bridge on the upper end and below the lower lip at the lower end for the facemask. For the nasal mask, the upper end will be kept at the nasal bridge and the lower end of the mask will be kept above the upper border of the upper lip. The patient's head will be placed in a neutral position on a pillow and elevated 10 cm from the operating room table. Trained anaesthesia practitioners with experience of more than 5 years will perform mask ventilation. Facemask ventilation will be performed by thumb and index finger holding the mask down over the nose and mouth of the patient, forming a C while the other three fingers of the hand grasp the patient's mandible, forming an E moving the mandible towards the upper teeth. The nasal mask ventilation will be performed by holding the mask with the left hand by placing the thumb and index finger on the body of the mask, while the middle, ring, and little fingers move the mandible toward the maxilla to ensure closure of the mouth.

After preoxygenation with 100% oxygen for three minutes using the standard technique, patients will be ventilated based on group allocation done using computer generated random number. In the first group, ventilation will be performed using the standard facemask and the second group patients will be ventilated using the nasal mask. Anaesthesia will be induced using an intravenous injection of fentanyl 2µg/kg followed by an injection of propofol 2 mg/kg. After the loss of consciousness and verification of ability to ventilate, Atracurium (0.5 mg/kg) will be administered. Patients will be ventilated with the volume-controlled mode of ventilation at a pre-set fresh gas flow of 10 l/min,

tidal volume of (6-7ml/kg), respiratory rate of 10 breaths/ min, pressure limit of 40 cm H2O for 2 minutes. The delivered tidal volume will be set according to adjusted body weight. Parameters of interest will be noted for ten breaths after verification of positive capnography tracing and expired tidal volume in each case.

A mean value of the parameters of these ten breaths will be calculated. If the patient is not ventilated adequately, defined as inadequate capnography trace/inadequate visual rising of the chest wall up to three breaths using facemask or nasal mask or both other airway adjuncts will be used as rescue airway.

Upon completion of the study, the subject's airway will be secured in a normal manner by the placement of an endotracheal tube/laryngeal mask airway.

Observations:

PRIMARY OUTCOME:

To compare the effectiveness of nasal mask ventilation versus face mask ventilation in obese patients by evaluating the expired tidal volume.

Statistical Analysis:

The statistical analysis will be carried out using IBM SPSS (Statistical Package for Social Sciences) statistical version 20. The analysis includes frequency table, bar, pie chart, association of variables based on Chi-square test and if any cell frequency is <5, then yates corrections will be used for 2x2 contingency table or method pooling and Fisher exact test will be used (for higher order than 2x2 table) and proportion will be compared using the z-proportion test. All quantitative variables will be estimated using measures of central location (mean and median) and measures of dispersion (standard deviation). Normality of data will be checked by Kolmogorov–Smirnov tests of normality. For normality distributed data, Mean will be compared in with respect to independent t-test (for two groups). For not normality distributed data, Median will be compared using Mann Whitney U test (for two groups). All statistical tests will be seen at two-tailed level of significance ($p \leq 0.01$ and $p \leq 0.05$).

Power and Sample Size

This calculator uses the following formula for the sample size n:

$n = (Z_{\alpha/2}+Z_{\beta})^2 * 2*\sigma^2 / d^2$,

where $Z_{\alpha/2}$ is the critical value of the Normal distribution at α/2 (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96), Z_{β} is the critical value of the Normal distribution at β (e.g. for a power of 90%, β is 0.1 and the critical value is 1.28), σ^2 is the population variance, and d is the difference.

F tests-t tests [Means: Difference between two dependent means

(matched pairs)].

Analysis: Post hoc: Compute achieved power

Calculating power for mean 1 = mean 2 + difference

Alpha = 0.05

Assumed standard deviation (Interquartile range = 285.6)

Difference -199.2

Sample Size for each group-45

Power -0.90

Actual Power 0.905266

Total Sample Size =90

A post hoc power analysis was conducted using the software package, G*Power version 3.1.9.2 (Franz Faul, university kiel, Germany). The alpha level used for this analysis was $p<0.05$ and beta was 0.20. Sample size was estimated from the results of previous study[9] using Expired tidal volume as the parameter, which is the primary outcome of our study .Our sample size came out to be 90 subjects (45 per group) at power of 0.90 with 10% chance of error with α = 0.05, β = 0.20 and confidence interval of 95%..

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

The study does not require any investigation or intervention other than those routinely done for every surgery.

7.4 HAS ETHICAL CLEARENCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Attached along with.

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PROFORMA

Sr. No. MRD. No.

Name:

Age and Sex:

Diagnosis:

ASA Grade: Surgery proposed:

Date of Admission: Date of surgery :

Height :

Actual body weight:

Adjusted body weight:

Ideal body weight:

BMI: STOP-BANG SCORE:

Neck circumference:

Anesthesiologist:

Past History-

- Previous Anaesthesia and surgery:

- Drug allergy:

General Physical Examination

Pallor/Icterus/cyanosis Pulse rate :

Edema/clubbing/lymph node Respiratory rate:

SIGNATURE OF CANDIDATE SIGNATURE OF SUPERVISOR

Parameters of study

	no of breath	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Facemask	Vte										
	Pip										
	$EtCO_2$										
	Spo_2										
	$P_{plateau}$										

	no of breath	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Nasal mask	Vte										
	Pip										
	$EtCO_2$										
	Spo_2										
	$p_{plateau}$										

Failure to ventilate using nasal mask:

Failure to ventilate using facemask:

Need for airway adjunct: YES/NO

SIGNATURE OF CANDIDATE

SIGNATURE OF SUPERVISOR

INFORMED PATIENT CONSENT

Date: _____

I.....D/o,W/o,S/o.....am willing to participate in the study **"EVALUATION OF NASAL MASK VS FACE MASK FOR VENTILATION DURING INDUCTION OF GENERAL ANAESTHESIA IN OBESE PATIENTS"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

.....
Signature of the Witness

.....
Signature of the patient

Name:

Signature of Supervisor

Signature of Candidate

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____ निवासी _____ इस शोधकार्य **"EVALUATION OF NASAL MASK VS FACE MASK FOR VENTILATION DURING INDUCTION OF GENERAL ANAESTHESIA IN OBESE PATIENTS"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____ਵਾਸੀ

_____

"EVALUATION OF NASAL MASK VS FACE MASK FOR VENTILATION DURING INDUCTION OF GENERAL ANAESTHESIA IN OBESE PATIENTS" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____
ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____

ਪਤਾ _____

_____
ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____

ਪਤਾ _____

_____
ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____
ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ